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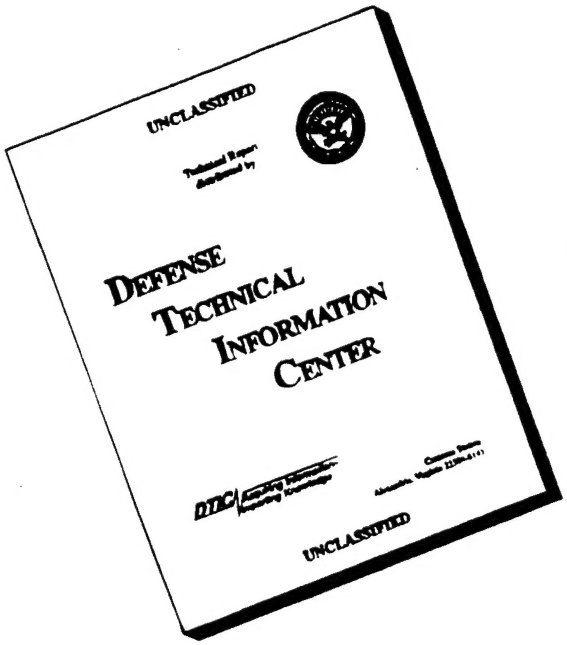

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CRREL Scientific and Technical Reports

Effective scientific and technical research depends on the transfer of information throughout the scientific community as well as the general dissemination of information to the public. CRREL has maintained an active publication program since its inception. This publications list is the supplement to the CRREL Publications List dated 1976–1990. The following descriptions are meant to clarify the CRREL report series.

CRREL Reports

The results of all major research efforts at CRREL are published in the CRREL Report series.

Special Reports

The Special Report series contains a wide variety of reports that do not fall within the CRREL Report category, e.g. literature reviews, data compilations, interim reports.

Monographs

The Cold Regions Science and Engineering Monograph series comprises comprehensive reviews of a field of scientific or technical knowledge with analysis and evaluation. This series is not published on a regular basis and the numbers and frequency vary from year to year. This series would be considered classics in the field of cold regions science and engineering.

Miscellaneous Publications

This series includes papers by CRREL authors that are published outside the laboratory but under CRREL funding. This series would include conference proceedings, contract reports, and journal articles.

Internal Reports and Technical Notes

Internal Reports are not listed in our publications list but frequently are referred to in literature cited by CRREL authors. These documents have not been published for reasons such as proprietary information, excessive expense, limited interest, or awkwardness of format. Copies are available for review in the CRREL Library or with the author's explicit release. Technical Notes are informal, preliminary, unedited, and frequently superceded by a more formal CRREL publication. These are also not available for external distribution without prior permission from the author.

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The *Bibliography on Cold Regions Science and Technology* has been sponsored at the Library of Congress by CRREL since 1951. This most important CRREL product has been published in volumes 1–15 as the *Bibliography on Snow, Ice and Permafrost*, SIPRE Report 12. Beginning with volume 16 the title was changed to *Bibliography on Snow, Ice, and Frozen Ground*, with Abstracts, and with volume 23 the current title was adopted. This publication differs from the CRREL Publications List because it includes all the world's cold regions research in addition to the CRREL in-house work.

Almost all the literature cited in the *Bibliography on Cold Regions Science and Technology* has been microfiched and is available in full text from the Library of Congress. If your requests number fewer than 10 you may borrow documents from the CRREL Library, 72 Lyme Road, Hanover, New Hampshire 03755-1290. Those interested in purchasing a photocopy of a document cited should write to the Library.

The *Bibliography* is available for purchase in three formats:

- Online searching is offered as FILE COLD through Orbit Search Service, 8000 Westpark Drive, MacLean, Virginia 22102 (phone 703-442-0900 or 800-445-7248).
- A CD-ROM version, *Arctic and Antarctic Regions*, is available from NISC, Suite 6, Wyman Towers, 3100 St. Paul St., Baltimore, Maryland 21218 (phone 301-243-0797 or FAX 301-243-0982).
- The paper version currently in 45 volumes is available for purchase from the National Technical Information Service (NTIS), Springfield, Virginia 22161 (phone 703-487-4650). The annual volume appears in two parts: author/subject index and the numerical listing. Every five years a five-year author/subject index has been published to simplify the search process.

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CR 82-43
RADAR DETECTION OF ICE WEDGES IN ALASKA.
Arcone, S.A., et al, Dec. 1982, 15p., ADA-124 571, 27 refs.
Sellmann, P.V., Delaney, A.J.
45-3021
ICE WEDGES, LAND ICE, RADAR, RADIO ECHO SOUNDINGS, REFLECTIVITY.
The radar signatures of ice wedges and wedge-like structures have been investigated for a variety of soil conditions. The radar used for this study emitted short sinusoidal pulses of about 10-ns duration with an approximate center frequency of 150MHz. Most of the ice wedges existed at depths of about 1 m in a variety of silty and sandy soils with both frozen and thawed active layers. The position of the wedges was usually identified from corresponding surface features. An artificial ice wedge in coarse-grained alluvium was also profiled as well as wedge-like structures of fine silt in a coarse-grained glacial outwash. All wedges and wedge-like structures produced a hyperbolic reflection profile except when an active layer of thawed, saturated silt was present which eliminated returns from the wedges. The peaks of the hyperbolas were sometimes masked by reflections from the permafrost table or other material interfaces, and multiple hyperbolas occurred at some sites. The dielectric constant of the host medium was often calculated from the linear portions of the hyperbolas and the results were verified by laboratory time domain reflectometry measurements performed on field samples. In some cases, hyperbolic profiles originated at several meters depth suggesting that deep ice wedges could be detected in areas of cold permafrost.

CR 90-02
LABORATORY TEST FOR MEASUREMENT OF ADHESION STRENGTH OF SPRAY ICE TO COATED FLAT PLATES.
Mulherin, N.D., et al, May 1990, 44p., ADA-228 559, 17 refs.
Richter-Menge, J.A., Tantillo, T.J., Gould, L.D., Durell, G.D., Elder, B.C.
45-976
SHIP ICING, SEA SPRAY, ICE ADHESION, CHEMICAL ICE PREVENTION, PROTECTIVE COATINGS, ICE REMOVAL, LABORATORY TECHNIQUES.
Four commercial icephobic coatings were selected as candidates for preventing and/or easing the removal of seaspray and atmospheric icing on shipboard superstructures. This study was undertaken to compare the force required to shear freshwater ice from flat test plates coated with the candidate materials. Twelve replicates each of the four different coatings and two different control surfaces (a total of 72 samples) were subjected to laboratory spray icing. The samples were iced and shear tested at -10 +/- 1 C at a constant crosshead displacement rate of 0.0381 cm/s. This shear rate was higher by at least an order of magnitude than that in most previous shear studies, ensuring a brittle failure at the ice/coating interface. The method produced virtually 100% ice/coating adhesion in every test, which eliminated analysis problems associated with cohesive failure. Results showed that all four of the experimental coatings exhibited higher mean shear values than either of the two controls. Although the mean shear values for the various coatings were very similar in absolute magnitude, ranging from 71 to 119 kPa, statistical analysis showed a significant difference in surface performance with greater than 97% confidence.

CR 90-06
LABORATORY INVESTIGATION OF THE USE OF GEOTEXTILES TO MITIGATE FROST HEAVE.
Henry, K.S., Aug. 1990, 28p., ADA-227 335, 27 refs.
45-841
SOIL WATER, FROST HEAVE, COUNTERMEASURES, HYDRAULICS, FROST PENETRATION, PAVEMENTS, GEOTEXTILES.
Frost action beneath pavements can lead to several problems, including thaw weakening, which leads to cracking and subsequent pumping of fine soil particles onto the surface, as well as hazardous conditions caused by differential heaving. This study utilized data and frost-susceptible soil collected at Ravalli County Airport, Hamilton, Montana, to study the use of geotextiles to mitigate frost heave. The ability of geotextiles to reduce frost heave in subgrade material by creating a capillary break was assessed by inserting disks of fabric in soil samples and subjecting them to laboratory frost heave tests. Frost heave tests were also conducted to classify the frost susceptibilities of soils at the airport. Soil moisture characteristics and unsaturated hydraulic conductivities were determined for soils tested as well as for one of the geotextiles used. Results of the laboratory investigation indicate that certain geotextiles show promise for use as capillary breaks. In laboratory tests, the presence of geotextiles led to the reduction of frost heave by amounts up to about 60%. It is speculated that the capillary break action provided by the geotextile is attributable to the pore size and structure of the material and the surface properties of the fibers.

CR 90-07
LONGITUDINAL FLOATING ICE CONTROL STRUCTURES: A NEW CONCEPT FOR REDUCING ICE JAM FLOOD LEVELS.
Calkins, D.J., Sep. 1990, 9p., ADA-228 561, 14 refs.
45-975
ICE CONTROL, ICE JAMS, RIVER ICE, FLOATING STRUCTURES, ICE BOOMS.
A floating ice control structure placed in the streamwise direction of a river was analyzed to determine its effectiveness in reducing ice jam thicknesses. The theory describing the thickness for river ice jams was modified to analyze these longitudinal structures, providing the computational verification that ice jam thicknesses could be reduced where the mode of thickening is internal collapse. These longitudinal structures may provide a new tool to use in modifying the river ice regime, both at freeze-up and break-up. The concept was applied to the Salmon River at Salmon, Idaho, where it was estimated that a 0.9 m drop in river stage was possible using one structure in the center of the channel.

CR 90-08
ESTIMATES OF SHOCK WAVE ATTENUATION IN SNOW.
Johnson, J.B., Oct. 1990, 14p., ADA-230 180, 8 refs.
45-1550
ATTENUATION, SHOCK WAVES, SNOW MECHANICS, SNOW PHYSICS, SNOW COMPACTION, MATHEMATICAL MODELS.
A simple momentum model, assuming that snow compacts to its final density at negligible stress, is used to estimate shock wave attenuation in snow. Four shock loading situations are examined: a one-dimensional pressure impulse of finite duration and instantaneously applied pressure impulses for one-dimensional, cylindrical and spherical shock geometries. Calculations show that while a finite-duration impulse is being applied, the shock pressure in snow is determined by the impulse pressure-time profile. After the pressure impulse has been applied, the one-dimensional shock pressure decay is the same as for an instantaneously applied pressure impulse and is proportional to the inverse square of the shock propagation distance. Hence, finite-duration pressure impulses delay the onset of shock attenuation in snow. This can result in more pressure attenuation near a shock source, where the positive phase duration of the shock is short, compared to shock waves farther from a source. Cylindrical waves have a maximum decay that is proportional to the inverse of the propagation radius to the fourth power, and spherical waves have a maximum decay that is proportional to R exp-6. Amplitude decay for cylindrical and spherical shock waves can vary from (R-R(0)exp-2, when (R-R(0)<<R(0) (where R(0) is the interior radius over which a pressure impulse per unit area is applied), to their maximum decay.

CR 90-09
WHEELS AND TRACKS IN SNOW: VALIDATION STUDY OF THE CRREL SHALLOW SNOW MOBILITY MODEL.
Blaisdell, G.L., et al, Nov. 1990, 72p., ADA-230 102, 10 refs.
Richmond, P.W., Shoop, S.A., Green, C.E., Alger, R.G.
45-1510
SNOW, SNOW STRENGTH, VEHICLES, TRACTION, COMPUTERIZED SIMULATION, MODELS, SNOW VEHICLES, TRACKED VEHICLES, TANKS (COMBAT VEHICLES), MILITARY EQUIPMENT, MOTOR VEHICLES.
In 1986, a mobility model was developed for predicting the traction and motion resistance of both wheeled and tracked vehicles on shallow snow, and a winter field season was dedicated to gathering mobility data for a diverse family of vehicles (including four on wheels and three tracked) to validate the model. The original version of the model, SSM1.0, used the Mohr-Coulomb shear failure equation from soil mechanics to predict gross traction. This required input of the snow strength parameters *c* and *phi*. Motion resistance is predicted by calculating the amount of work done by the tire in compacting snow and only requires snow depth and density values as input snow properties. Some effort was expended in determining an easy and reliable method of obtaining snow strength parameters. The model was originally designed to use an initial snow density-snow strength relationship established from past instrumented vehicle test results. Historically, shear annulus apparati have been used to obtain Mohr-Coulomb strength parameters. A comparison of snow strength obtained via these three methods (shear annulus, instrumented vehicle, calculated from initial density using the relationship in SSM1.0) for individual snow covers showed no agreement. SSM1.0 assumed that snow strength parameters for mobility prediction were a function of initial snow density; however, traction is developed in the compacted snow under the driving element, whose strength properties bore little relation to those of the initial snow. It appears that the shear strength of the compacted snow is essentially a constant for all of the vehicles and snow covers tested here.

CR 90-10
PREDICTING THE BEHAVIOR OF ASPHALT CONCRETE PAVEMENTS IN SEASONAL FROST AREAS USING NONDESTRUCTIVE TECHNIQUES.
Janoo, V.C., et al, Nov. 1990, 56p., ADA-231 292, 16 refs.
Berg, R.L.
45-1699
CONCRETE PAVEMENTS, FROST HEAVE, THAW WEAKENING, THAW DEPTH, FREEZE THAW TESTS, BITUMINOUS CONCRETES, LABORATORY TECHNIQUES.
Four different pavement test sections were subjected to freeze-thaw cycling in CRREL's Frost Effects Research Facility (FERF). The test sections, each 610 cm in length, consisted of 1) 15.2 cm of asphalt concrete pavement over a clay subgrade, 2) 15.2 cm of asphalt concrete over 10.2 cm of crushed gravel over a clay subgrade, 3) 5.1 cm of asphalt concrete over 25.4 cm of crushed gravel over 12.7 cm of clean sand over a clay subgrade. Thermocouples were imbedded throughout the pavement structure and subgrade. During the thawing periods, deflection measurements were made at four locations in each test section using a Dynatest Falling Weight Deflectometer (FWD). The results of the deflection measurements are presented here. An analysis was done to quantify the subgrade strength based solely on FWD measurements. It was also shown that a relationship existed between thaw depth and FWD measurement in the subgrade.

CR 90-12
WINTER ENVIRONMENT OF THE OHIO RIVER VALLEY.
Daly, S.F., et al, Dec. 1990, 57p., ADA-232 134, 26 refs.
Bilello, M.A., Bates, R.E.
45-1999
RIVER ICE, CLIMATIC FACTORS, AIR TEMPERATURE, WATER TEMPERATURE, ICE CONDITIONS, UNITED STATES—OHIO RIVER.
A general survey of the winter environment of the Ohio River Valley that is relevant to river ice formation is described. Included are hydrologic, hydraulic and climatic conditions. The long-term monthly discharges steadily increase on the Ohio River throughout the winter season. Inspection of the discharges for each day shows that it has a large short-term variability during the winter, with peaks being four to six times the base flow, and generally coinciding with higher air temperatures. River water temperatures follow a yearly cycle that can be closely described by a sinusoidal curve. The river water temperatures have their minimum in Jan., and also exhibit Jan. "thaws." Ice conditions on the Ohio River are quite variable. The number of days with ice each winter has gradually and erratically decreased from 1902 to 1975. The cause of this decrease cannot be determined, but there is a direct correlation with watershed development, as indicated by watershed population Average air temperatures show a good correlation with elevation. Other points discussed are mean minimum air temperatures, freezing-degree days and precipitation.

CR 90-13
WHEELS AND TRACKS IN SNOW; SECOND VALIDATION STUDY OF THE CRREL SHALLOW SNOW MOBILITY MODEL.
Richmond, P.W., et al, Dec. 1990, 39p., ADA-232 866, 8 refs.
Blaisdell, G.L., Green, C.E.
45-2094
TIRES, SNOW STRENGTH, SNOW VEHICLES, VEHICLES, COMPUTERIZED SIMULATION, MODELS, TRACKED VEHICLES, TRACTION, MILITARY EQUIPMENT, MOTOR VEHICLES.
This report presents and analyzes winter mobility data obtained during the winters of 1988 and 1989 at the Keweenaw Research Center, Houghton, MI. Traction data (1989) for the HMMWV, HEMTT, SUSV and M60 military vehicles, and the CRREL instrumented vehicle, are presented for hard-packed snow and for undisturbed snow overlaying ice. When these data are compared with an equation for undisturbed snow over soil or packed snow, slight reductions in traction are observed. Resistance data obtained in 1988 and in 1989 are evaluated based on a combined vehicle-snow parameter. An empirical equation based on this parameter and data from all the vehicles, including the CRREL instrumented vehicle using several different width tires, is developed. The resistance data and the empirical resistance equation are

compared with the CRREL shallow snow mobility (SSM2.0). The SSM2.0 predicted resistance is within 50% on average. The empirically derived resistance equation is slightly worse. The report recommends further research on vehicle motion resistance in snow.

CR 91-01
USE OF INSULATION FOR FROST PREVENTION: JACKMAN AIRPORT, MAINE, 1986-1987 WINTER.
Kestler, M.A., et al, Jan. 1991, 45p., ADA-234 274, 5 refs.
Berg, R.L.
45-2643
RUNWAYS, THERMAL INSULATION, FROST PROTECTION, PAVEMENTS, FROST HEAVE, FROST PENETRATION.
In 1986, Newton Field, a small runway in Jackman, ME, was reconstructed using a 2 inch thick layer of extruded polystyrene insulation. At the same time, Nichols Road, a nearby town road, was reconstructed to a conventional, uninsulated cross section. Both Newton Field and Nichols Road were similarly monitored: thermocouples, tensiometers, and groundwater wells were installed during construction, and, following construction, a pavement surface elevation grid was established at each of the test sites for monitoring frost heave. This report discusses the performance of the insulated and uninsulated pavements during the first of four winters of observation.

CR 91-02
ROTATING MULTICYLINDER METHOD FOR THE MEASUREMENT OF CLOUD LIQUID-WATER CONTENT AND DROPLET SIZE.
Howe, J.B., Jan. 1991, 18p., ADA-234 780, 11 refs.
45-2642
CLOUD DROPLETS, UNFROZEN WATER CONTENT, MEASURING INSTRUMENTS, AIRCRAFT ICING.
Since its development at the Mount Washington Observatory in the 1940s, the rotating multicylinder (RMC) method has been the simplest, most reliable, and usually the most accurate means of measuring the liquid-water content and droplet size in clouds and fog. The development history of the method is reviewed in this report. Fabrication of the instrument, exposure and data-reduction techniques, and the underlying theory of the method are described in detail. Accuracy of the RMC method is discussed and comparison tests with other instruments are briefly reviewed.

CR 91-03
COMPUTER MODEL OF ATMOSPHERIC ICE ACCRETION ON TRANSMISSION LINES.
Jones, K.F., et al, Feb. 1991, 24p., ADA-234 273, 34 refs.
Egelhofer, K.Z.
45-2641
POWER LINE ICING, ICE ACCRETION, ICE LOADS, WIND PRESSURE, MATHEMATICAL MODELS, COMPUTERIZED SIMULATION.
Atmospheric ice accretions on transmission lines cause increased gravity and wind loads on the lines. In regions subject to icing conditions, transmission line design must take these loads into account. This report describes a numerical model for determining the accretion of ice on transmission lines. The eccentric ice load causes a gradual rotation of the flexible conductor, which affects the shape and size of the accretion. The sensitivity of the gravity and wind load on the conductor to both atmospheric and structural variables is examined.

CR 91-04
LOW-TEMPERATURE EFFECTS ON THE DESIGN AND PERFORMANCE OF COMPOSTING OF EXPLOSIVES-CONTAMINATED SOILS.
Ayorinde, O.A., et al, Mar. 1991, 29p., ADA-236 420, 68 refs.
Reynolds, C.M.
45-2917
SOIL POLLUTION, WASTE TREATMENT, EXPLOSIVES, MICROBIOLOGY, DECOMPOSITION, COLD WEATHER OPERATION, MILITARY FACILITIES, ANALYSIS (MATHEMATICS).
It is well known that energy, in the form of heat, is released through microbial conversion of chemical species in a compost system. This heat energy is a major factor in the performance of the compost system and the effects of climate, especially subfreezing temperatures, may require engineering controls. This report reviews the literature on the effects of cold climates on composting. The suitability of current compost system designs for remediating explosives-contaminated soils in cold regions is discussed and a theoretical heat balance is performed. Results indicate that cold climate composting may be performed with appropriate controls; however, lack of operational data for analysis requires reliance on theoretical models that may be overly simplified. The complex relationships between physical parameters in compost systems are also discussed.

CR 91-05
PERSONNEL AND CARGO TRANSPORT IN ANTARCTICA; ANALYSIS OF CURRENT U.S. TRANSPORT SYSTEM.
Blaisdell, G.L., Mar. 1991, 63p., ADA-236 142, 5 refs.
45-3109
SLEDS, SNOW VEHICLES, TRANSPORTATION, TRACTORS, TRACKED VEHICLES, AIR CUSHION VEHICLES, AIRPLANES, HELICOPTERS.
An analysis of the National Science Foundation's surface vehicle fleet in Antarctica is reported on here. Surface vehicle needs have been determined through interviews of vehicle users, managers and maintainers, and from direct on-site observation. An ideal grouping of vehicle categories is proposed that will address current needs and provide flexibility for the future. Recommendations for streamlining and modernizing the NSF antarctic vehicle fleet are made. Cargo transportation over snow was identified as being in a crisis state. Personnel movement functions for all but traversing are performed adequately at this time, although there is much room for improvement. Brands and models must be selected for some categories of recommended vehicle types. This will naturally follow a more in-depth analysis of candidates and discussions with NSF vehicle managers. A purchasing plan, including a timetable, budget, and desired sequence of replacement, must then be formulated and executed. (Auth.)

CR 91-06
SLUDGE DEWATERING IN A FREEZING BED —A PILOT-SCALE STUDY.
Martel, C.J., et al, Apr. 1991, 14p., ADA-235 995, 11 refs.
Diener, C.J.
46-216
SLUDGES, WASTE TREATMENT, FREEZE THAW CYCLES, INSOLATION, COLD WEATHER PERFORMANCE, MELTWATER, WATER TREATMENT, DESIGN, TEMPERATURE EFFECTS, COLD WEATHER TESTS.
In 1986 a pilot-scale sludge freezing bed was constructed at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH. This bed was operated over the next three years using both anaerobically and aerobically digested sludges. These tests demonstrated that both sludges can be effectively dewatered by this process. The final solid contents were 39.3% and 24.5% for anaerobically digested and aerobically digested sludges, respectively. The quality of the meltwater was similar to raw wastewater. Odors were not a problem if the meltwater was drained away as quickly as it formed. Both sludges were easily removed with a front-end loader. The actual depth of sludge frozen and thawed in the bed during each year of operation was very close to that predicted by design models.

CR 91-07
PERFORMANCE OF ASPHALT CONCRETE AIRPORT PAVEMENTS DURING THAW WEAKENING PERIODS; A FIELD STUDY.
Janoo, V.C., et al, Apr. 1991, 68p., ADA-237 441, 13 refs.
Berg, R.L.
45-2956
AIRPORTS, RUNWAYS, CONCRETE PAVEMENTS, THAW WEAKENING.
It is accepted that in the winter the load-carrying capacity of pavements increases dramatically because of freezing of the pavement structure. This is more striking in asphalt concrete pavements because of the stiffening of the asphalt at low temperatures. In the spring, the pavement structure below the asphalt layer thaws and can become saturated with water from the melting ice lenses, reducing the strength of the base, subbase and subgrade. In the spring of 1986, CRREL conducted Falling Weight Deflectometer (FWD) measurements at an airfield in Wisconsin, which had pavements that were primarily asphalt concrete, to determine the change in the load-bearing capacity of these pavement structures in a seasonal frost area during thaw weakening periods. In addition to FWD measurements, surface and subsurface pavement temperatures were measured at selected sites. This report gives a general description of the airfield and the pavement structure and a comprehensive analysis of the FWD measurements.

CR 91-08
LOW TEMPERATURE DECONTAMINATION WITH DS2: STUDIES WITH CHEMICAL AGENT SIMULANTS.
Parker, L.V., et al, Apr. 1991, 23p., ADB-156 188, 19 refs.
Walsh, M.E.
45-3260
MILITARY RESEARCH, LOW TEMPERATURE RESEARCH, COLD WEATHER PERFORMANCE, ICING.
Experiments were performed to determine factors that significantly influence the efficiency of DS2 for decontamination using chemical agent simulants. Several surface types and conditions that may be encountered on a winter battlefield were tested. The three simulants used in this study were: BIS, tDEM, and DMMP. Generally, decontamination was reduced at lower temperatures. At -29 C, the DS2 was extremely viscous, and scrubbing was required to spread the DS2 evenly over the contaminated area. The presence of dirt and oil significantly reduced decontamination efficiency in the cold, while the presence of ice did not adversely affect decontamination. Following decontamination, removal of the simulant was not enhanced by rinsing surfaces with 100 C water, as opposed to 0 C water, but icing of the sample surfaces was reduced when hot water was used. As an alternative to an aqueous rinse, DS2 may be removed by wiping with a paper towel without decreasing removal efficiency. For the experiments performed on painted (alkyd and CARC) surfaces, two major differences were observed between the 22 C and -29 C tests: alkyd paint was not damaged by the DS2 at the low temperature and while decontamination efficiencies were equal on alkyd- and CARC-covered and unpainted metal surfaces at -29 C, they varied dramatically at 22 C. Based on the information available in the literature and from this study with simulants, decontamination with DS2 and a water rinse is not practical at temperatures much below -30 C. At these low temperatures, the logistics of dispensing the DS2 and rinsing it away with water become unreasonable.

CR 91-09
REMOTE SENSING OF SNOW COVERS USING THE GAMMA-RAY TECHNIQUE.
Offenbacher, E.L., et al, Apr. 1991, 19p., ADA-238 016, 28 refs.
Colbeck, S.C.
45-3259
REMOTE SENSING, SNOW WATER EQUIVALENT, SNOW COVER, SNOW SURVEYS, AERIAL SURVEYS.
This report reviews various aspects of the use of natural gamma-ray emissions to determine the mass of snow covering the ground. The interactions of gamma rays with water mass are described, along with the various sources of gamma radiation from the ground. Different possible techniques for measuring gamma radiation are described. Each has advantages and disadvantages in obtaining the desired result. The source of error and the use of this method are described.

CR 91-10
IMPULSE RADAR BATHYMETRIC PROFILING IN WEED-INFESTED FRESH WATER.
Kovacs, A., Apr. 1991, 19p., ADA-237 489, 20 refs.
45-2955
SOUNDING, RADAR, UNDERWATER ACOUSTICS.
An evaluation of an impulse radar sounding system for profiling bottom topography in weed-infested waters is discussed. Field results are presented comparing radar profiles of water depth with those obtained with a conventional acoustic depth sounder. It was found that the impulse radar system could profile freshwater depths through dense vegetation, whereas the acoustic depth sounder could not.

CR 91-11
INTERPRETATION OF PASSIVE MICROWAVE IMAGERY OF SURFACE SNOW AND ICE—HARDING LAKE, ALASKA.
Melloh, R.A., et al, June 1991, 30p., ADA-239 140, 24 refs.
Eppler, D.T., Farmer, L.D., Gatto, L.W., Chacho, E.F., Jr.
46-44
LAKE ICE, ICE CONDITIONS, AERIAL SURVEYS, IMAGING, SNOW COVER EFFECT, RADIOMETRY, MICROWAVES, PHOTOINTERPRETATION, SURFACE PROPERTIES, CORRELATION, BRIGHTNESS.
This report presents interpretations of snow and ice conditions on Harding Lake, Alaska, using 33.6-GHz passive microwave imagery acquired from 1500 m on 8 and 11 March 1988, when snow conditions were dry and wet, respectively. Field data used include an aerial video mosaic, ice column descriptions, snow observations and an impulse radar trace. Results show that low-altitude passive microwave imagery is a promising method for remote/field investigation of large-scale lake ice processes. Fracture patterns in the lake ice were detected where snow ice had formed above and near cracks in the ice cover. Presumably, bubbles in the snow ice layer scattered less energy than the depth hoar crystals over the adjacent ice surface, resulting in warmer brightness temperatures over the fractures. Brightness temperatures of a continuous and deeper snowcover at the northwest end of the lake were low compared to the combined radiance of snowdrifts and pockets of bare ice across the lake surface.

CR 91-12
EVALUATION OF A PORTABLE ELECTROMAGNETIC INDUCTION INSTRUMENT FOR MEASURING SEA ICE THICKNESS.
Kovacs, A., et al, June 1991, 17 refs., ADA-240 974, 12 refs.
Morey, R.M.
46-262
ICE COVER THICKNESS, ELECTROMAGNETIC PROSPECTING, SOUNDING, ICE SURVEYS, SEA ICE, MEASURING INSTRUMENTS.
Field trials using a man-portable Geonics, Ltd., EM31 electromagnetic induction sounding instrument, with a plug-in data processing module, for the remote measurement of sea ice thickness, are discussed. The processing module was made by Flow Research, Inc., to directly measure sea ice thickness and show the result in a numerical display. The EM31-

processing module system was capable of estimating ice thickness within 10% of the true value for ice from about 0.7 to 3.5 m thick, the oldest undeformed ice in the study area. However, since seawater under the arctic pack ice has a relatively uniform conductivity (2.5 +/- 0.05 S/m), a simplified method, which can be used for estimating sea ice thickness using just an EM31 instrument, is discussed. It uses only the EM31's conductivity measurement, is easy to put into use and does not rely on theoretically derived look-up tables or phasor diagrams, which may not be accurate for the conditions of the area.

CR 91-13
POTENTIAL INFLUENCES OF COMMON WELL CASINGS ON METAL CONCENTRATIONS IN WELL WATER WITH LOW DISSOLVED OXYGEN.
Hewitt, A.D., July 1991, 17p., ADA-241 014, 12 refs.
46-266
WELL CASINGS, GROUND WATER, WATER POLLUTION, WATER CHEMISTRY, ENVIRONMENTAL PROTECTION, LEACHING.

Both the leaching and sorption characteristics of poly)vinyl chloride) (PVC), poly(tetrafluorethylene) (PTFE) and two types of stainless steel (SS 304 and SS 316) well casing materials were examined by determining levels of Cd, Cr, Cu, Pb, Fe and Ni in an aqueous solution. Experiments were conducted under a nitrogen environment in well water having low dissolved oxygen, without visible surface oxidation of the stainless casings. Under conditions typical of deep wells, PTFE was inert, whereas both stainless steels significantly altered the solution chemistry for most of the metals cited above. PVC was generally more reactive than PTFE, but did not dominate solution chemistry; neither was it as variable in its influence as the metal casings.

CR 91-14
GROUNDWATER-DISCHARGE WETLANDS IN THE TANANA FLATS, INTERIOR ALASKA.
Racine, C.H., et al, July 1991, 10p., ADA-241 282, 28 refs.
Walters, J.C.
46-1048
WETLANDS, GROUND WATER, SWAMPS, VEGETATION PATTERNS, PERMAFROST HYDROLOGY, RIVER BASINS, DRAINAGE, THERMOKARST, UNITED STATES—ALASKA—TANANA RIVER.

In the northwest corner of the Tanana Flats, a lowland basin just south of Fairbanks, there is a vast network of floating-mat wetlands or fens that appear to be unique in terms of their origin, large areal extent, and absence of *Sphagnum* moss and associated peat. These wetlands consist of a floating vegetation mat up to 1 m thick, forming an almost complete cover over deeper water bodies. The mats consist of a tall, dense and productive network of emergent vascular plants. Evidence that these wetlands are formed by groundwater discharge includes a) the apparent absence of permafrost under these wetlands but its presence on the adjacent forested uplands, b) nearby winter icings resulting from artesian springs, c) the relatively high pH, conductivity, calcium and magnesium concentrations of the water, d) the vascular plant species composition and in particular the absence of *Sphagnum* moss, and e) the flow of water and the geological history of the area. Expansion of these fens in several places is suggested by dead and dying white birch along the along-fen margin, where permafrost thaw and subsidence (thermokarst) is taking place.

CR 91-15
INVESTIGATIONS OF FRESHWATER AND ICE SURVEYING USING SHORT-PULSE RADAR.
O'Neill, K., et al, July 1991, 22p., ADA-241 435, 18 refs.
Arcone, S.A.
46-1047
ICE SURVEYS, ICE COVER THICKNESS, RADAR ECHOES, AERIAL SURVEYS, LAKE ICE, RIVER ICE, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS).

An overview is presented of recent activities and results in the use of commercially available short-pulse UHF radar for surveying ice conditions on freshwater bodies Improvements in radar systems have made it possible to increase ice thickness resolution by as much as one third relative to that in past attempts, and some new signal processing approaches shown here may offer an order of magnitude improvement. Results from airborne surveying are shown. An algorithm is presented that locates returns from interfaces in the presence of noise for a non-minimum delay wavelet. The method performs a simple inversion in the frequency domain, enhanced by a time dependent weight designed to recognize the shape of the wavelet amplitude and phase spectra. Thin ice layers are resolved down to a few centimeters and are distinguished from an ice-free condition by means of a matched filter system designed to recognize the interference pattern from parallel interfaces close to one another.

CR 91-16
NUMERICAL MODELS FOR FORECASTING ICE CONDITIONS ON THE OHIO RIVER.
Shen, H.T., et al, Sep. 1991, 55p., ADA-243 336, 20 refs.
Bjedov, G., Daly, S.F., Lal, A.M.W.
46-1869
ICE MODELS, MATHEMATICAL MODELS, ICE COVER, COMPUTERIZED SIMULATION, RIVER ICE, FRAZIL ICE, ICE CONDITIONS, ICE FORECASTING, ICE NAVIGATION, THEORIES, ICE JAMS, WATER TEMPERATURE, UNITED STATES—OHIO—OHIO RIVER.

A numerical model, RICEOH, for simulating flow and ice conditions in a dendritic river system is developed. The flow computations use a double-sweep algorithm for unsteady shallow-water wave equations. The distributions of water temperatures and ice concentration are determined using a Lagrangian-Eulerian scheme. The formation of an ice cover is modeled using existing equilibrium ice jam theories. Frazil ice deposition and erosion are modeled by a simple critical-velocity criterion. The thermal growth and decay of an ice cover is calculated by a quasi-steady finite-difference method. The model is applied to the Ohio River system between Pittsburgh, PA, and Meldahl, OH. Comparisons with field observations show that the model can provide good simulation for ice conditions.

CR 91-17
GEOPHYSICAL INVESTIGATIONS OF AN ANOMALOUS UNFROZEN ZONE, CARIBOU PEAK, ALASKA.
Lawson, D.E., et al, Oct. 1991, 23p., ADA-244 257, 34 refs.
Arcone, S.A., Collins, C.M.
46-1870
GROUND WATER, PERMAFROST DISTRIBUTION, PERMAFROST HYDROLOGY, TALIKS, GEOPHYSICAL SURVEYS, UNITED STATES—ALASKA—CARIBOU PEAK.

The occurrence of unfrozen materials and groundwater flow on a north-facing slope in interior Alaska is important to recognize, both for predicting the spatial distribution of perennially frozen ground as well as for understanding watershed hydrology. An anomalous unfrozen zone or talik was located on the northern slope of Caribou Peak by drilling in Apr. 1985. Impulse radar surveying of the area immediately adjacent to this drill hole, as well as on three transects upslope of its location, revealed that the unfrozen zone is the result of groundwater flow in the bedrock along a relatively planar zone, interpreted as a fracture. This fracture and two others located by the radar are continuous in the direction of the slope, trending generally N20E and dipping about 9E. Geologic logs indicate that the drill hole intersected a fracture in the bedrock, a quartz-muscovite schist, at a depth of about 8.5 to 9.0 m. Downhole measurements show ground temperatures at this depth are generally uniform and slightly above freezing throughout the year, suggesting continuous flow of groundwater within the planar structure. Analysis of the freezing point of the groundwater sample indicates normal freezing beginning at 0 C, while ion chromatography indicated that the water was fresh and not highly mineralized. Vegetation patterns, coupled with the borehole location and fracture orientation, suggest that flow originates within the upper and central parts of the peak and discharges into the valley of Poker Creek. The source of the groundwater is unknown, but appears to be an aquifer in the south-facing, non-permafrost side of Caribou Peak that is intersected by the north-south striking fractures. These fractures then transmit the water to the northern face and channel it through the permanently frozen layer beneath this side. In addition to identifying these unfrozen, localized groundwater flows within perennially frozen bedrock, the radar profiles also revealed signatures that suggest a transition in unfrozen water content within the marginally frozen colluvium.

CR 91-18
ANALYSIS OF RIVER ICE MOTION NEAR A BREAKING FRONT.
Ferrick, M.G., et al, Oct. 1991, 17p., ADA-243 431, 9 refs.
Weyrick, P.B., Hunnewell, S.T.
46-1871
RIVER ICE, ICE BREAKUP, VELOCITY.

A quantitative theory of dynamic river ice breakup is not yet available. One of the essential components of such a theory is a description of the ice motion near the breaking front. In this report the authors develop an analysis of this motion for a specific case that is consistent with observed data. The analysis is generalized by allowing the speed of the breaking front to vary, and the parameters of the ice motion that are obtained represent different dynamic breakup behaviors that have been described previously. The results of the analysis include 1) the hydraulic radius associated with the ice cover and the total ice acceleration as functions of time, 2) the equilibrium ice velocity as a function of bank resistance, and the ice velocity as a function of time for several initial and bank resistance conditions, 3) the time-varying bank resistance at the measurement location, and 4) the time of ice motion, ice velocity, ice acceleration, and the convergence of the moving ice with distance from the breaking front. The measure of ice convergence quantifies the loss of surface area by the sheet that is required for ice continuity, and distinguishes the types of dynamic breakup.

CR 91-19
ROLE OF THERMAL CONVECTION IN HEAT AND MASS TRANSPORT IN THE SUBARCTIC SNOW COVER.
Sturm, M., Oct. 1991, 82p., ADA-243 674, Refs. p.67-72. For Ph.D. thesis of same title see 45-505.
46-1872
METAMORPHISM (SNOW), AIR FLOW, CONVECTION, DEPTH HOAR, SNOW COVER, THERMAL CONDUCTIVITY, WATER VAPOR, VAPOR TRANSFER, HEAT TRANSFER, MASS TRANSFER.

The purpose of this study was to investigate the role of air convection in moving heat and water vapor in snow. To detect convection, the three-dimensional temperature field in the Fairbanks snow cover was measured hourly three winters (1984-1987). Measurements of snow density, compaction, and grain size were made monthly to determine the water vapor flux and textural changes. The snow metamorphosed into depth hoar, producing a sequence of five layers, including a basal layer with horizontal c-axes. C-axes in the overlying layers were vertical or randomly oriented. As the depth hoar developed, its air permeability increased to a value several times higher than previously measured for any snow, while the number of snow grains per unit volume decreased by an order of magnitude as a few select grains grew while others sublimated away. Simultaneously, there was a net transfer of mass from the base to the top of the snow due to mass flux gradients that averaged .000003 kg/m2/s/m, but were occasionally 10 times higher. Convection occurred sporadically in the winter of 1984-85 and continuously in the winters of 1985-86 and 1986-87. The evidence was 1) simultaneous warming and cooling at different locations in a horizontal plane in the snow, and 2) horizontal temperature gradients of up to 16 C/m. The convection was time-dependent, with perturbations such as high wind or rapid changes in air temperature triggering periods when horizontal temperature gradients were strongest, suggesting these were also periods when the air flow was fastest. During the winter, warm and cold zones developed in the snow and remained relatively fixed in space. The zones were probably the result of a diffuse plume-like convection pattern linked to spatial variations in the temperature of the snow/soil interface. Air flow was inferred to have been horizontal near the base of the snow and vertical elsewhere. Flow averaged 0.2 mm/s, with a maximum of 2 mm/s. During average flow conditions, convection moved about a third of the total heat, but did not move significant mass. However, the coincidence of crystals with horizontal c-axes and the horizontal flow lines at the base of the snow suggest that convection may have affected crystal growth direction.

CR 91-20
ENERGY ABSORPTION OF GRAPHITE/EPOXY PLATES USING HOPKINSON BAR IMPACT.
Dutta, P.K., et al, Oct. 1991, 18p., ADA-244 256, 13 refs.
Hui, D., Altamirano, M.R.
46-1873
COMPOSITE MATERIALS, LOW TEMPERATURE TESTS, DAMAGE, WAVE PROPAGATION, TEMPERATURE EFFECTS, VELOCITY.

This work summarizes the analytical and experimental study on the energy absorption of quasi-isotropic graphite/epoxy composite plates due to the impacting hemispherical penetrator in a Hopkinson bar apparatus. The mechanics of stress wave propagation through the bar and the composite laminate plate are discussed to predict the phenomenological process involved. The experimental data provided the results in terms of force, velocity, and energy of impact at all times during the penetration process occurring in microseconds. It has been concluded that loss of contact occurs frequently during the penetration process due to the stress wave reflections back and forth in the thickness direction. The damage process seemed to be both velocity and temperature dependent. Below a certain transition velocity the laminate absorbs less energy at low temperature than at high temperature. The reverse is true above this transition velocity. The mechanism of failure tends to change with impact velocity in such a way that progressively less energy is absorbed at higher velocities.

CR 91-21
CONSTRUCTION GUIDELINES FOR OIL AND GAS EXPLORATION IN NORTHERN ALASKA.
Crory, F.E., Nov. 1991, 83p., Refs. p.81-83.
46-2563
ENVIRONMENTAL IMPACT, ICE RUNWAYS, COLD WEATHER CONSTRUCTION, SNOW ROADS, COLD WEATHER OPERATION, AIRCRAFT LANDING AREAS, PETROLEUM INDUSTRY, GAS PRODUCTION, DESIGN CRITERIA, TUNDRA, PERMAFROST.

This report addresses the unique problems associated with oil and gas explorations in northern Alaska and provides background information on the climate and environment, including the permanently frozen ground that exists throughout the area. Information on exploration efforts in the 1940s and 1950s is also included to demonstrate what happens when summertime operations disturb the surface vegetation and thermal regime of the frozen tundra; this is the reason why such operations are no longer permitted. Separate chapters are provided on the design, construction and operation

of winter trails, roads, airfields and drill pads, including a separate chapter on their abandonment. Emphasis is placed on how, why and when to perform the various tasks to successfully accomplish an exploration.

CR 91-23
DETERMINING THE INTRINSIC PERMEABILITY OF FRAZIL ICE. PART 1. LABORATORY INVESTIGATIONS.
White, K.D., Dec. 1991, 15p., ADA-248 325, 17 refs.
46-3037
FRAZIL ICE, PERMEABILITY, RIVER ICE, ICE MECHANICS, LABORATORY TECHNIQUES.
The intrinsic permeability of frazil ice describes the capacity for flow through the ice matrix and can be used to estimate the porosity of the deposit. There are no existing in-situ tests for determining the intrinsic permeability of a frazil ice deposit. The borehole dilution test, an in-situ, relatively nondestructive test often used in soils testing, was modified for use in frazil ice. In this test the dilution of a dye tracer introduced into a borehole made in a laboratory frazil ice deposit was measured over time. The test results were used to find the seepage velocity through the frazil deposit, from which the intrinsic permeability is calculated using the Dupuit-Forchheimer approximation to flow between two reservoirs. The results from the laboratory experiments indicate that the test may be modified for use as an in-situ method to determine intrinsic permeability in frazil ice deposits.

CR 92-01
VECTOR ANALYSIS OF ICE FABRIC DATA.
Ferrick, M.G., et al, Mar. 1992, 17p., ADA-250 832, 20 refs.
Claffey, K.J.
46-4000
SEA ICE, ANALYSIS (MATHEMATICS), ICE MECHANICS, ICE CRYSTALS, ORIENTATION.
The mechanical properties of ice are strongly affected by crystal texture and c-axis alignment. In this report a general quantitative method for analysis of uniaxial crystal orientation data was developed. These data are represented as unit vectors from the origin with endpoints on the surface of a unit sphere. An orthogonal least-squares error measure is used to develop equations that define the closest plane and line through the data. The resulting eigenvalue problem is identical to that obtained by other investigators using different methods. However, an implicit assumption in the method was identified, and it was observed that the error measure represents physical distance and quantifies the goodness-of-fit of the idealized structures to the data. For comparison, a parallel development is presented of classical dependent-variable least squares. A method is developed to transform the data and the results for viewing on Schmidt nets drawn in the best plane and the predominant basal plane of a sample, in addition to the standard *xy*-plane. Applications of the analysis to sea ice samples include both numerical and Schmidt net presentations of results.

CR 92-02
AIR TIGHTNESS MEASUREMENT TECHNIQUE FOR MULTIPLEX HOUSING.
Flanders, S.N., Mar. 1992, 11p., ADA-250 831, 5 refs.
46-4003
AIR FLOW, BUILDINGS, HOUSES, MEASUREMENT.
This report develops means to evaluate the air tightness of multiple-residence buildings using fan pressurization apparatuses. The fan pressurization apparatuses are mounted in the doors of adjacent attached dwellings, either to equalize pressures between dwellings or to coordinate a pressure difference. Equalization of pressures between adjacent zones permits evaluation of the exterior envelope tightness. Coordination of pressures between adjacent zones permits evaluation of the tightness of party walls or floors. The report discusses the sampling requirements necessary to achieve adequate precision for calculating an equivalent leakage area, L, from each mode of pressurization. Several field studies of multiple-residence buildings at Fort Drum, NY, provided an opportunity to test the principles described in this paper. The buildings measured often had very consistent values of L per unit of envelope area or party wall or roof area within a neighborhood constructed by the same contractor. Confidence limits obtained for calculating L gave a 95% chance of being within bounds determined by the following factors: 1) zone difference measurements had an upper limit of 1.1 or a lower limit of 1/1.1; and 2) pressure difference measurements across a party wall or floor had an upper limit of 1.4 to 5.5 or a lower limit of 1/1.4 or 1/5.5.

CR 92-03
SLOW GROWTH OF ICE CRYSTALS IN WATER.
Colbeck, S.C., Mar. 1992, 10p., ADA-251 864, 12 refs.
46-4371
ICE CRYSTAL GROWTH, FRAZIL ICE, SLUSH, ICE CRYSTAL STRUCTURE.
Ice crystals were slowly grown in supercooled water at growth rates spanning those for slush to those for frazil. All of the crystals were disks with aspect ratios between 2 and 35, which increased with growth rate. The growth rates were much less than expected from theory, possibly because of crowding in the experiment. The shapes showed a gradual transition from well-rounded to highly-faceted as the growth rate increased. Even in the lower range of growth rates the crystals do not undergo metamorphism during growth, so the kinetics of crystal growth controls the shape over the entire range of growth rates investigated here. This explains why all of the crystals were disk shaped, as opposed to the well-rounded crystals seen in slush.

CR 92-04
MODEL FOR VERTICAL FRAZIL DISTRIBUTION.
Liou, C.P., et al, Apr. 1992, 14p., ADA-251 519, 30 refs.
Ferrick, M.G.
46-4054
FRAZIL ICE, TURBULENT FLOW, MATHEMATICAL MODELS, RIVER ICE.
A model is presented for the evolution of frazil over depth and with time in a turbulent flow. The net upward migration due to buoyancy of the frazil is opposed by intermittent mixing induced by large energy-containing eddies. A surface renewal model is used to describe the effects of large eddy mixing. Parameters that represent an entire water body are obtained by averaging those of discrete water columns using a probability density function. These parameters include the concentration profile, the surface age, and the surface layer thickness. A dimensionless surface renewal frequency characterizes the frazil distribution at equilibrium. The rate of heat loss from the water surface, the surface renewal frequency, and the critical surface layer thickness determine whether the frazil will evolve toward a well-mixed equilibrium state or a layered state. The model provides a physical basis for understanding the transition between these states, consistent with existing empirical criteria and field data.

CR 92-05
WATERFOWL MORTALITY IN EAGLE RIVER FLATS, ALASKA: THE ROLE OF MUNITIONS RESIDUES.
Racine, C.H., et al, May 1992, 37p., ADA-252 646, 35 refs.
Walsh, M.E., Collins, C.M., Calkins, D.J., Roebuck, B.D., Reitsma, L.
46-4462
MILITARY OPERATION, ENVIRONMENTAL IMPACT, ANIMALS, PHYSIOLOGICAL EFFECTS.
The death of hundreds of migrating dabbling ducks and 10-50 swans has been documented annually for the last ten years in Eagle River Flats (ERF), an estuarine salt marsh on Ft. Richardson, AK. This marsh has been used for the past 40 years as an artillery impact range by the U.S. Army. During May and Aug. 1990, CRREL collected 250 sediment and water samples and analyzed them for munitions residues. The authors found 2,4-DNT in a limited area of Eagle River Flats not used by waterfowl, and white phosphorus in sediments from the bottom of shallow ponds where waterfowl feed. Tissues from waterfowl observed to die or found dead in the salt marsh were collected, and white phosphorus was found in the gizzards of all 11 carcasses collected in Eagle River Flats. Adult mallards dosed in the laboratory with white phosphorus showed identical behavioral symptoms to those of wild ducks observed to become sick and die in Eagle River Flats. All evidence indicates that white phosphorus, as a particulate in the sediments, is responsible for the death of waterfowl in Eagle River Flats. Since the bottom sediments of the shallow salt marsh ponds are anaerobic, the white phosphorus particles will persist in the sediments indefinitely and remain a threat to waterfowl.

CR 92-06
AQUEOUS EXTRACTION—HEADSPACE/GAS CHROMATOGRAPHIC METHOD FOR DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN SOILS.
Hewitt, A.D., et al, Apr. 1992, 14p., ADA-253 124, 27 refs.
Miyares, P.H., Leggett, D.C., Jenkins, T.F.
46-5148
SOIL POLLUTION, ENVIRONMENTAL IMPACT.
This study compares aqueous extraction-headspace/Gas Chromatography (GC) and the EPA SW-846 purge-and-trap-gas chromatography/mass spectrometry (Method 8240) for the determination of four common Volatile Organic Compounds (VOCs) in soils. Comparisons were made on two fortified soils and two contaminated field soils. In only two of the cases were consistent significant differences found —for the two most hydrophobic compounds in a high organic carbon soil, and for TCE in a field-contaminated soil that had previously shown slow aqueous VOC desorption. The findings strongly suggest that aqueous extraction-headspace/GC can be used not only to screen soils for VOCs giving same-day results, but often will provide results not significantly different from current laboratory based measurements.

CR 92-08
SUB-BOTTOM SURVEYING IN LAKES WITH GROUND-PENETRATING RADAR.
Sellmann, P.V., et al, May 1992, 18p., ADA-252 860, 17 refs.
Delaney, A.J., Arcone, S.A.
46-5146
ANTENNAS, RADAR, UNDERWATER ACOUSTICS, LAKES, SOUNDING.
Short-pulse radar was used on lakes in New Hampshire for sub-bottom surveying. The objectives were to construct a low-frequency, high-powered antenna suited for this application, and to evaluate the technique under a range of sub-bottom conditions. A compact 50-MHz antenna with a hydrodynamic housing was fabricated for this study. The transmitter provided a peak input power of approximately 1000 W and noise was decreased by submerging the separated antennas on each side of a fiberglass boat to assure consistent coupling. A 100-MHz commercial antenna unit placed in the bottom of the boat and a 7-kHz acoustic sounder, both of which had vertical resolution theoretically comparable or superior to that of the 50-MHz radar, and theoretical studies of antenna directivity were used to help evaluate the results. In shallow water of 1-2 m depth, estimates of the thickness of low density organic sediments (1-4 m thick) over more dense bed material were obtained at both radar frequencies. Noticeable apparent sedimentary bedding and layering, various sediment types and variations in the depth to bedrock beneath the bed were obtained in low-conductivity lake water more than 20 m deep with the higher powered 50-MHz system. Maximum bed penetration was at least 7 m in these cases, and vertical bedding resolution was far superior to the acoustic results. Radar bathymetry and limited sub-bottom data were obtained in water up to 30 m deep.

CR 92-09
PERFORMANCE OF INSULATED PAVEMENTS AT NEWTON FIELD, JACKMAN, MAINE.
Kestler, M.A., et al, May 1992, 24p., ADA-254 017, 10 refs.
Berg, R.L.
46-5147
FROST PENETRATION, INSULATION, FROST HEAVE, CONCRETE PAVEMENTS, COLD WEATHER PERFORMANCE.
In 1986 the runway at Newton Field, a small airport in Jackman, ME, was reconstructed using a 2 in.-thick layer of extruded polystyrene insulation as part of the pavement structure. At the same time, a nearby town road was reconstructed using a conventional noninsulated pavement cross section for relatively heavy loads. Both pavements were monitored for frost penetration, frost heave, and seasonal changes in pavement strength. Since frost penetration beneath the insulation layer of the runway at Newton Field exceeded empirical estimates during winter 1986-1987, four additional test sections with varying combinations of insulation and subbase thicknesses were constructed adjacent to the airport's parking apron during summer 1987. Although the thermal performance of the insulated pavement test sections was comparable to design expectations for the following 3 years, evidence of discontinuities in the insulation layer in the Newton Field runway demonstrates the insulated pavement's susceptibility to variations in construction technique and site conditions. This report discusses pavement performance at each of the test sites over the observation periods 1986-1990 and 1987-1990.

CR 92-11
ANALYSIS OF A PASSIVE INFRARED PERIMETER SECURITY SYSTEM.
Lacombe, J., et al, June 1992, 32p., ADB-166 114, 11 refs.
Peck, L.
46-5317
DETECTION, THERMAL RADIATION, THERMAL ANALYSIS, SENSORS.
An assessment has been made of the capabilities of a passive infrared intrusion detection sensor (PIR). The study involved a series of field tests and the development of a sensor model. The field tests were conducted during the spring of 1991 at the South Royalton Intrusion Detection Systems (SOROIDS) test site in Vermont. These tests documented the ability of two ELTEC Model 862-71C PIRs to detect a heated 0.3 m (1-ft) diameter target as it moved through the surveillance zone of the two sensors. Thermal contrast and speed thresholds required to alarm the sensors were identified from the test data using a binary decision-tree classification process. A simple model has been developed that predicts sensor performance based on target and background temperatures, target dimensions and target speed. Results from analyses of the heated target test data appear to verify its accuracy. The model has been exercised for a variety of input conditions to demonstrate its general utility. Limitations of the model have been identified and tasks proposed to improve its accuracy, extend its use for slow-moving targets (i.e., speeds less than 0.5 m/s), and incorporate the effects of natural obscuration. By linking this model to surface temperature thermal algorithms, it should be possible to predict thermal contrast (and sensor performances) based on environmental inputs.

SPECIAL REPORTS

SR 82-29
COLD WEATHER CONSTRUCTION MATERIALS PART 2: FIELD VALIDATION OF LABORATORY TESTS ON REGULATED-SET CEMENT FOR COLD WEATHER CONCRETING.
Houston, B.J., et al, Dec. 1982, 27p., ADA-124 526, 6 refs. For another version see 36-1028.
Hoff, G.C., Sayles, F.H.
45-3475
COLD WEATHER CONSTRUCTION, CONCRETE PLACING, CONSTRUCTION MATERIALS, CEMENTS, CONCRETE ADMIXTURES, COLD WEATHER TESTS, CONCRETE CURING, CONCRETE STRENGTH, CHEMICAL COMPOSITION.
The Army carries on construction projects in localities where the concrete placing season is shortened considerably by the cold climate. This study evaluates "regulated-set" cement, which is a fast setting, rapid strength gain cement, that appeared to have great promise and would allow concrete to be placed at ambient temperatures as low as 15 F. Both mortars and concretes made with regulated-set cement were studied in the laboratory with favorable results, so the laboratory results were validated with field testing. Two test slabs were cast when the mean ambient temperature was approximately 15 F. The only differences in the two slabs were the concrete mixture temperature and air entrainment, and the slabs received no special protection from the ambient temperatures. Neither slab obtained any appreciable compressive strength at 1 day but slab 1 had approximately 1200 and 2000 psi at 7 and 28 days, respectively, while slab 2 had 2200 and 3300 psi, respectively. Since there was no strength gain at day 1, whereas there had been in laboratory tests of approximately the same concrete mixture but with an earlier shipment of regulated-set cement, a sample of the cement from the field test was brought to the laboratory for comparison with the cement used in the laboratory tests. Chemical and physical tests indicated that there was a difference in chemical composition; the laboratory shipment had a higher sulfate content. This difference points out the need for a responsive purchase specification, which is presently not available.

SR 84-16
CATALOG OF SMOKE/OBSCURANT CHARACTERIZATION INSTRUMENTS.
O'Brien, H.W., ed, June 1984, 184p., For another version see 39-2950.
Bowen, S.L., ed.
45-3476
MILITARY RESEARCH, TEST EQUIPMENT, RADIATION MEASURING INSTRUMENTS, RECORDING INSTRUMENTS, LIGHT TRANSMISSION, AEROSOLS, SCATTERING, ATMOSPHERIC COMPOSITION, METEOROLOGICAL DATA, RADIOMETRY, SNOW CRYSTAL STRUCTURE, SNOW COMPOSITION.
A survey of field test instrumentation that is currently used by DOD agencies and their civilian contractors to characterize smokes, dust and debris, and natural obscurants has been carried out by the U.S. Army Cold Regions Research and Engineering Laboratory for the Project Manager for Smoke-/Obscurants. The results of the survey are compiled in this catalog. The catalog includes instruments that directly measure, or through some computation lead to the generation of data relating to: 1) luminance and radiance, 2) transmittance or attenuation, 3) airborne-obscurant particle size and concentration, 4) cloud mechanics, and 5) meteorological parameters. It also provides information concerning instrumentation for appropriate 6) data acquisition and processing, and 7) documentation or other special-purpose information.

SR 90-03
LABORATORY COMPARISON OF FIELD TECHNIQUES FOR MEASUREMENT OF THE LIQUID WATER FRACTION OF SNOW.
Boyne, H.S., et al, Feb. 1990, 8p., ADA-219 587, 8 refs.
Fisk, D.J.
45-560
SNOW WATER CONTENT, MEASUREMENT.
The amount and distribution of liquid water in a snow cover is important for assessing its mechanical strength, meltwater generation and meltwater transmission. It also has a profound effect on the performance of active and passive remote sensing systems operating in the microwave and millimeter wave regions of the electromagnetic spectrum. New methods of measuring liquid water have been reported that show considerable promise. This report describes tests of measurement equivalence, in which are compared the three absolute methods of freezing calorimetry, alcohol calorimetry and dilution. Also compared are a capacitance snow moisture meter and one of the absolute methods. All comparisons were made in a laboratory coldroom using homogeneous snow with a mass liquid water content that varied from 0 to 14%. The comparisons show that the methods are equivalent and that the experimental errors associated with the measurements are consistent with what is expected from an error analysis of each method. However, the operational achievement of equivalence depends strongly on a variety of factors such as sample size, mixing of snow and working fluid, and operator skill.

SR 90-14
ICE FORCES ON FLAT, VERTICAL INDENTORS PUSHED THROUGH FLOATING ICE SHEETS.
Nakazawa, N., et al, May 1990, 62p., ADA-223 420, 37 refs.
Sodhi, D.S.
45-937
ICE LOADS, ICE COVER STRENGTH, ICE CRACKS, CRACKING (FRACTURING), PENETRATION TESTS, IMPACT TESTS.
Structures placed in an ice environment should be able to withstand the ice forces that are produced by the motion of a floating ice sheet. To observe the crushing failure of ice and to characterize the magnitude and nature of ice forces, an experimental study was conducted by pushing vertical, flat indentors through floating ice sheets made up of freshwater, columnar ice. Depending on the velocity of the indentor, ductile or brittle behavior of ice was observed. Microcracks and macrocracks were observed during the tests. The energy used to produce the maximum ice force was found to be approximately the same for different indentor velocities. The positions of the resultant forces were found to be in the center of the contact area. The area of the ice damaged by the first peak loading of the indentor was about the same, even when the indentor velocities were different. Acoustic emission signals were measured during indentation experiments, and these were found to correlate with the ice force that produces strain and microcracking in the ice.

SR 90-16
PURITY DETERMINATION OF STANDARD ANALYTICAL REFERENCE MATERIALS BY DIFFERENTIAL SCANNING CALORIMETRY.
Black, P.B., et al, May 1990, 6p., ADA-224 669, 11 refs.
Pidgeon, D.
45-90
TEMPERATURE MEASUREMENT, MATERIALS, TESTS, MILITARY RESEARCH.
As part of the United States Army Toxic and Hazardous Materials Agency (USATHAMA) Quality Assurance program to maintain a set of high-purity (>98 mol%) Standard Analytical Reference Materials (SARMs), the SARMs' purity must be routinely monitored. This report presents data on melting temperature, freezing point depression and heat of fusion as measured by differential scanning calorimetry (DSC) for the seven SARMs suited to DSC methods. These data were then used in the van't Hoff's equation to determine each munition standard's molar purity. The purity of each tested SARM was greater that 98 mol%, which confirmed the integrity of the SARMs.

SR 90-18
FENCE CHARACTERIZATION FOR INTRUSION DETECTION SYSTEMS.
Walsh, M.R., et al, May 1990, 23p., ADA-223 564, 2 refs.
Peck, L.
45-98
EQUIPMENT, TESTS.
Equipment and test procedures for quantifying the normal stiffness, transverse stiffness, post rigidity and post plumbness of a chain-link fence are described. These parameters characterize the condition of the fence and determine its suitability for use with a fence-mounted intrusion detection system.

SR 90-23
EVALUATION OF PVDF PIEZOPOLYMER FOR USE AS A SHOCK GAUGE.
Dutta, P.K., et al, June 1990, 11p., ADA-225 955, 7 refs.
Kalafut, J.
46-2921
POLYMERS, SHOCK WAVES, STRESSES, FROZEN GROUND MECHANICS, MEASURING INSTRUMENTS.
Polarized polyvinylidene fluoride film (PVDF) is a unique piezoelectric material with a very high sensitivity to shock pressure. It is also highly pliable. A large number of shock gauges were fabricated using this material; they were then calibrated and evaluated in the Split Hopkinson Pressure Bar Apparatus. Shock waves of defined geometry were passed through these test gauges and their responses were measured. Application of these gauges is foreseen in ground shock measurements where stress perturbations because of gauge inclusion in the media have to be minimized. This report discusses the development, construction and evaluation of these gauges.

SR 90-25
FREEZE-THAW TESTS OF FULL-SCALE ROLLER-COMPACTED CONCRETE TEST SECTIONS.
Cortez, E.R., et al, July 1990, 14p., ADA-228 577, 13 refs.
Eaton, R.A.
46-5073
CONCRETE PAVEMENTS, CONCRETE DURABILITY, CONCRETE FREEZING, FREEZE THAW TESTS, FROST RESISTANCE, COLD WEATHER PERFORMANCE.

SR 90-26
ANALYSIS OF WINTER LOW-FLOW RATES IN NEW HAMPSHIRE STREAMS.
Melloh, R.A., Aug. 1990, 12p., ADA-229 512, 11 refs.
45-1260
DRAINAGE, STREAM FLOW, SEASONAL VARIATIONS, WINTER, FLOW RATE, CLIMATIC FACTORS, STREAMS, RUNOFF.
The timing and magnitude of winter low flows vary regionally in response to basin climate and geology. This report investigates the regionalization of low flows in the White Mountain and Upland physiographic sections of New Hampshire to establish a data set that will be used in improved analytical methods for estimating winter flows. For the summer and winter low flow periods, 3-, 7-, 14- and 30-day duration low flow events are estimated for various sizes of drainage areas (50 to 230 square miles). The likelihood of a low-flow event increases as winter proceeds in the White Mountains, but is more evenly distributed throughout the winter in the Upland. White Mountain streams have higher runoff volumes through all seasons, except winter. The average magnitudes of winter low-flow events in both physiographic sections are highly correlated with drainage area size. Mean basin elevation was of little additional help in explaining winter low-flow events within either physiographic section, though it was important in explaining summer low-flow variation in the White Mountains.

SR 90-27
IN-SITU DETECTION OF CONTAMINANT PLUMES IN GROUND WATER.
Seitz, W.R., Aug. 1990, 12p., ADA-228 409, 53 refs.
45-935
GROUND WATER, WATER POLLUTION, SPECTROSCOPY, HYDROCARBONS, IONS.
Ground-water contaminants can be detected in situ by making spectroscopic measurements through fiber optics. In addition to direct measurements, it is possible to couple fiber optics with chemical indicators that interact with the contaminants to enhance their detectability. Direct fluorescence measurements have been used to sensitively detect aromatic hydrocarbons in fossil fuels. Direct Raman measurements are also possible but can only detect relatively high concentrations (greater than 0.1%). Parts per billion levels of nitroaromatics and halogenated hydrocarbons can be detected using indicators that react to form colored products. The rate at which the absorbance of the colored product increases is proportional to concentration. Refractive index measurements offer a rugged reversible approach to detecting organic contaminants in the low parts per million range. All of these techniques require further development before they can be reliably used on a routine basis. Other spectroscopic techniques are considered in the report, but are not considered ready for in-situ ground-water monitoring at this time.

SR 90-28
COMPARISON OF TEST METHODS FOR DETERMINATION OF FLEXURAL STRENGTH IN UREA MODEL ICE.
Borland, S.L., Aug. 1990, 9p., ADA-227 781, 12 refs.
45-840
UREA, ICE MODELS, FLEXURAL STRENGTH, ICE STRENGTH.
Laboratory tests were performed in a basin to compare the flexural strength of urea ice obtained by three different beam test methods. The beam test methods used were the *in-situ* three-point loaded simple beam test, the out-of-water three-point loaded simple beam test and the *in-situ* cantilever beam test. There is essentially no difference in flexural strength determined from either of the three-point beam tests, and the flexural strength obtained from either of the three-point beam tests is also approximately equal to the value determined from the *in-situ* cantilever beam test. A reduction in flexural strength with increases in beam length-to-thickness ratio was observed for portions of the data set.

SR 90-29
MODEL STUDY OF THE CAZENOVIA CREEK ICE CONTROL STRUCTURE.
Gooch, G.E., et al, Aug. 1990, 31p., ADA-228 032, 8 refs.
Deck, D.S.
45-934
ICE CONTROL, ICE JAMS, ICE PREVENTION, FLOOD CONTROL, ICE MODELS.
An ice control structure was chosen as a solution to ice-jam flooding of the business and residential communities of West Seneca and Buffalo, New York, along Cazenovia Creek. A model study was proposed to evaluate its performance before actual construction. This report describes the design, execution, and results of the model study, which led to the eventual acceptance of the proposed ICS by the U.S. Army Engineer District, Buffalo.

SR 90-30
SALTING-OUT SOLVENT EXTRACTION METHOD FOR DETERMINING LOW LEVELS OF NITROAROMATICS AND NITRAMINES IN WATER.
Miyares, P.H., et al, Aug. 1990, 26p., ADA-227 761, 6 refs.
Jenkins, T.F.
45-663
WATER CONTENT, GROUND WATER, WATER POLLUTION, EXPLOSIVES.
A protocol was developed for determining low levels of nitroaromatics and nitramines in ground water. Sample preparation employs salting-out extraction with acetonitrile and NaCl, further preconcentration of extract by solvent evaporation on a Kuderna-Danish concentrator, dilution of the concentrate with water, and filtration through a 0.5 micron Millex-SR filter. Separation is achieved using reversed-phase high-performance liquid chromatography with an LC-8 (3.3 cm) column using a 70.7/27.8/1.5 (v/v/v) water-methanol-THF eluent, and determination is obtained on a UV detector at 254 nm. This procedure provides far lower detection limits than the earlier protocol, which involved direct injection onto an LC-18 (25 cm) column eluted with 50/50 (v/v) methanol-water. The new method is capable of simultaneously determining RDX, TNB, DNB, TNT, 2,4-DNT, 2,6-DNT, 2-Am-DNT and 4-Am-DNT in less than five minutes, with reporting limits ranging from 0.02 to 0.84 microgram/L. Analytical recovery averaged greater than 95%.

SR 90-31
ENVIRONMENTAL INFLUENCES ON MINE DETECTION.
Hogan, A.W., et al, Aug. 1990, 6p., ADB-149 274, 16 refs.
Leggett, D.C., Lacombe, J.
45-933
MINES (ORDNANCE), DETECTION, VAPOR TRANSFER, EXPLOSIVES, MILITARY OPERATION, ANALYSIS (MATHEMATICS).
Research has been conducted to determine the probable influence of the environment on the operational use of chemical vapor "sniffing" devices for standoff mine detection. Experiments indicate that the external surfaces of mines become contaminated with TNT during storage and that this contamination provides a strong vapor source, detectable by several types of sniffing devices. A model calculation is performed to determine the TNT vapor generated by a "standard" minefield pattern. This calculation, carried out over the several Pasquill categories, estimates the source strengths of TNT vapor emanating from contaminated mine surfaces at 100-m horizontal distance from the minefield. Additional operational meteorological problems that need to be solved relate to airborne or ground platforms to carry the sniffing devices, and possible rates of advance consistent with varying meteorological conditions.

SR 90-32
ANTIFREEZE ADMIXTURES FOR COLD REGIONS CONCRETING: A LITERATURE REVIEW.
Korhonen, C.J., Sep. 1990, 14p., ADA-228 560, 35 refs.
45-974
WINTER CONCRETING, CONCRETE ADMIXTURES, ANTIFREEZES.
Winter concreting practices in the U.S. are geared toward assuring that chemical admixtures can be used to depress the freezing point of mix water, thereby allowing cement to hydrate at below-freezing temperatures. With these admixtures, strength gain at low temperature lags that of additive-free concrete at room temperature, but nevertheless, strength gain is significant. Though questions still remain on the short- and long-term effects of these admixtures on concrete, they appear to offer an economical alternative to conventional concreting practices.

SR 90-33
HIGHWAY SNOW CONTROL RESEARCH IN JAPAN.
Itagaki, K., Sep. 1990, 60p., ADA-228 937, 129 refs.
45-999
SNOW REMOVAL, ROAD MAINTENANCE, ARTIFICIAL MELTING, RESEARCH PROJECTS, SNOW MELTING, SNOW FENCES, JAPAN.
The wide range of Japanese efforts to control snow and ice on highways is reviewed. Many studies parallel U.S. and European research, but extensive basic studies of applications of modern high technology are noted as well.

SR 90-34
IN-HOUSE LABORATORY INDEPENDENT RESEARCH PROGRAM—FY88.
Diemand, D., ed, Oct. 1990, 18p., ADA-229 665.
Moritz, M., ed.
45-1399
RESEARCH PROJECTS, ICE, SNOW, FROZEN GROUND.
CRREL's In-House Laboratory Independent Research (ILIR) Program provides a means for innovative high-risk basic research. This report briefly describes the 17 ILIR research projects undertaken in FY88. Work in this program addressed various problems concerning the physical properties of ice, snow and frozen ground; remote sensing of lake and river ice; water content of frozen or partially frozen materials; and physical/mathematical models for experimental or predictive use in ice research.

SR 90-35
LABORATORY AND FIELD TESTS OF A WIRE MESH FRAZIL COLLECTOR.
Foltyn, E.P., Oct. 1990, 10p., ADA-230 181, 9 refs.
45-1511
FRAZIL ICE, RIVER ICE, ICE CONTROL, DESIGN, FLOODING.
Frazil ice jams on rivers cause problems that range from slowing commercial river traffic to widespread flooding. Through the years, one of the accepted techniques of controlling frazil ice jams has been to retain the frazil ice in a location where it will not harm the environment, using dams or weirs. In the interest of developing an inexpensive ice control structure, a series of laboratory and field tests were conducted using different wire mesh structures as a dam to determine which type of wire mesh best retains ice and what the optimum orientation of that mesh should be. A material such as chain link fence fabric would collect and retain the ice, but proper bed preparation must be done to prevent bed scour. Further study is required to determine the optimum mesh size.

SR 90-36
SCHEDULING FALL SEEDINGS FOR COLD-CLIMATE REVEGETATION.
Racine, C.H., et al, Oct. 1990, 6p., ADA-229 742, 10 refs.
Bailey, R.N., Palazzo, A.J.
45-1664
REVEGETATION, GRASSES, DEGREE DAYS, GROWTH.
Revegetating construction sites in the fall requires the scheduling of seeding and mulching for either permanent or dormant seedings. Dormant seedings must be late enough in the fall to prevent germination, while permanent seedings must be early enough to permit seedling establishment and avoid winterkill. A technique for determining optimum seeding dates using growing degree-day curves was developed and tested. Small outdoor plots and buried pots in Hanover, NH, were seeded with tall fescue at intervals during Oct. 1988 and 1989, respectively, and covered with either straw mulch or a Typar row cover. Soil surface temperatures, germination and growth were monitored into the following springs. Fall or spring germination of fall-sown tall fescue seeds required about 100 GDDs (growing degree days) (over 5 C), while the development of a second leaf required an additional 70 GDDs. In the experimental plots without any cover, these requirements were met with Oct. 12 and Oct. 5 seedings, respectively; with a Typar cover, seeding dates could be delayed by one week. In pots the greatest spring yields were obtained under Typar at the earliest (5 Oct.) seeding date and the latest dormant seeding date (2 Nov.). Straw mulch applied during the fall had little or no effect on the number of growing degree-days remaining. However, during the following spring, it slowed soil warming and germination of dormant seedings. The appropriate fall seeding date for northern areas can be calculated using a power curve for Hanover, NH: Julian date=360 x (GDDs required) exp-0.05.

SR 90-37
COLD TOLERANCE OF PLANTS USED FOR COLD-REGIONS REVEGETATION.
Reid, W.H., et al, Oct. 1990, 15p., ADA-229 864, Refs. p.9-15.
Palazzo, A.J.
45-1433
REVEGETATION, PLANTS (BOTANY), COLD TOLERANCE.
Only a fraction of the world's plant species can tolerate freezing, and all exhibit various forms of damage after exposure to extreme cold. Some species, on exposure to low, nonfreezing temperatures, exhibit enhanced tolerance through a genetically determined process called cold hardening. Cold tolerance is attributed partly to the accumulation of soluble carbohydrates, soluble proteins and lipids in cells, and to the proliferation of intracellular membranes. There are several methods of testing for cold tolerance. Plant nutritional status may increase or decrease cold tolerance. Several chemicals, among them a fungicide, have been found to reduce cold tolerance. Water stress improves cold tolerance. Research is needed in several areas to improve the success and lower the cost of revegetation projects. The genetics of cold tolerance is poorly understood. Research on cold tolerance with combined stresses is needed. Simulation analysis of plant growth in cold climates is important if carbon balance is to be understood. Applied research is needed in several areas: appropriate statistical descriptions of climate, remote sensing for terrain evaluation, analysis to determine plant and soil temperatures in relation to air temperature; and complex revegetation strategies involving plant succession on disturbed lands. Cold-regions soil microbiology, important in plant success, is poorly known. A clearing house for information on plant cold tolerance and cold-regions revegetation would reap great reward for efficient reclamation.

SR 90-38
DEVELOPMENT OF A SIMPLIFIED FIELD METHOD FOR THE DETERMINATION OF TNT IN SOIL.
Jenkins, T.F., Nov. 1990, 18p., ADA-230 182, 1 ref.
45-1586
EXPLOSIVES, SOIL POLLUTION, GROUND WATER, MILITARY OPERATION.
A simple field method was developed for determining the concentration of 2,4,6-trinitrotoluene (TNT) in soil. The method involves extraction of the soil with acetone, generation of the red-colored Jackson-Meisenheimer anion by addition of potassium hydroxide and sodium sulfite, and measurement of color intensity at 540 nm using a battery-operated spectrophotometer. The method was shown to follow the Beer-Lambert law with linear calibration through an absorbance of 0.9 absorbance units, and was found to be both precise and accurate in tests with spiked soils, providing a detection limit of about 1 microgram/gram. The extraction step recovered a mean of 96% of the TNT recoverable by a more exhaustive laboratory extraction procedure. A comparison was made of concentration estimates from the field method with those from the standard RPHPLC laboratory procedure using a set of field-contaminated soils. An excellent correlation existed between the two when both 1,3,5-trinitrobenzene and TNT concentrations from the laboratory measurements were included. The method is susceptible to interference from a number of polynitroaromatic compounds including the following: 1,3,5-trinitrobenzene (red), tetryl (orange), 2,6-dinitrotoluene (pinkish purple), 2,4-dinitrotoluene (blue) and 1,3- dinitrobenzene (purple). No color was observed for nitramine explosives, such as RDX or HMX, or nitrate esters such as nitroglycerine or pentaerythritol tetranitrate. The method was field tested at Umatilla Army Depot and found to provide a simple, rapid method for estimating TNT concentrations in the field. Concentration estimates from field analysis correlated well with laboratory analyses of the same samples.

SR 90-39
MODELING ICE PASSAGE THROUGH SUBMERGIBLE AND NON-SUBMERGIBLE TAINTER GATES.
Gooch, G., et al, Nov. 1990, 75p., ADA-231 358.
Rand, J., Hanamoto, B., Zufelt, J.
46-5123
LOCKS (WATERWAYS), ICE CONTROL, ICE NAVIGATION, SPILLWAYS, SLUICES (HYDRAULIC ENGINEERING), HYDRAULIC STRUCTURES, MODELS.
In the cold regions of the U.S., ice accumulation in the approach area of navigation locks has been a constant problem. This ice is often pushed into the lock ahead of a towboat, sometimes requiring a separate lock cycle. This reduces the efficiency of the lock and slows down ship traffic. By modeling this problem and testing the solution to it, the research team has been able to conclusively show that submergible tainter gates located near the approach will solve the above-mentioned ice problems.

SR 90-40
ICE FORMATION IN FREQUENTLY TRANSITED NAVIGATION CHANNELS.
Ettema, R., et al, Dec. 1990, 110p., ADA-232 115, 48 refs.
Huang, H.P.
45-1972
RIVER ICE, ICE NAVIGATION, ICE FORMATION, CHANNELS (WATERWAYS), ICE GROWTH, ICE MODELS, MATHEMATICAL MODELS, SHIPS.
Results are reported of a study aimed at determining and documenting the effects of frequent vessel transit on ice-cover formation over navigation channels. A practical objective of this study was to evaluate the merits of scheduling vessel transits as a means of mitigating problems caused by transiting of ice-covered channels. Vessels transiting through ice covers lead to increased ice growth and transform ice to brash ice, which collects in thick accumulations that may halt traffic. The study entailed extensive laboratory experiments conducted with an ice tank and model hulls that simulated river tows and ships. It also included the formulation and use of a numerical model of ice formation. Another brief study examined the mechanics of ice accumulation beneath flat-bottomed tows. The results from the ice-tank experiments and the numerical model indicate that, except for convoys of vessels, the problems incurred by frequent transiting are not readily mitigated by a sophisticated transiting schedule. Convoying does hold promise of reducing the severity of the problem because it reduces the number of icebreaking transits. Of greater promise, however, is

an approach involving mechanical methods for controlling brash-ice accumulations at perennially difficult channel locations.

SR 90-42
CRREL RESEARCH ON MATERIALS IN COLD ENVIRONMENTS.
Dutta, P.K., Dec. 1990, 20p., ADA-232 133, 35 refs.
45-2002
LOW TEMPERATURE TESTS, MATERIALS, COLD WEATHER PERFORMANCE, TENSILE PROPERTIES, LOW TEMPERATURE RESEARCH.
This report is a synopsis of the developments in the materials research program at CRREL. Focusing on studies of the low-temperature behavior of materials, the report reviews these developments in three specific areas: creating a materials-property data base, researching composites and other materials and developing test facilities. Among materials, composites, being newer, have been studied in depth. Temperature and strain rate have been considered critical in influencing any material's durability; therefore, facilities were developed to provide precise control of these parameters. The program aims to meet the crucial need for designing structures and equipment using materials specifically adapted for cold regions and low-temperature applications.

SR 90-43
ICE JAM ANALYSIS AT IDAHO FALLS, SNAKE RIVER, IDAHO.
Zufelt, J.E., et al, Dec. 1990, 18p., ADA-232 226, 4 refs.
Earickson, J.A., Cunningham, L.
45-2035
FRAZIL ICE, ICE CONTROL, ICE JAMS, FLOODING, HYDRAULICS, UNITED STATES—IDAHO—SNAKE RIVER.

SR 90-44
PROCEEDINGS OF THE 47TH ANNUAL EASTERN SNOW CONFERENCE, BANGOR, ME, JUNE 7-8, 1990.
Eastern Snow Conference, 1990, 250p., ADA-233 320, Refs. passim. For selected papers see 45-2182 through 45-2203.
Ferrick, M.G., ed, Pangburn, T., ed.
45-2181
SNOWFALL, SNOW COVER, SNOWMELT, LAKE EFFECTS, RIVER ICE, MELTWATER, SNOW AIR INTERFACE, ICE COVER STRENGTH, SNOW WATER EQUIVALENT, SNOW SURVEYS, RUNOFF.

SR 91-01
MEMBRANE FOR IN-SITU OPTICAL DETECTION OF ORGANIC NITRO COMPOUNDS BASED ON FLUORESCENCE QUENCHING.
Seitz, W.R., et al, Jan. 1991, 10p., ADA-244 261, 12 refs.
Jian, C., Sundberg, D.C.
46-1864
EXPLOSIVES, DETECTION.
Quenching of emission from fluorescent membranes was evaluated for detecting organo nitro compounds used as explosives. The most sensitive membrane is prepared using solvent casting from cyclohexanone to incorporate pyrenebutyric acid into cellulose triacetate plasticized with isodecyldiphenyl phosphate. The response appears to follow the Stern-Vollmer law for TNT and DNT. The membrane also responds to RDX, but with less sensitivity. Detection limits are approximately 2 ppm for DNT and TNT and 10 ppm for RDX. Attempts were made to adapt the membrane for remote in-situ measurements. In this context, the extent of quenching needs to be determined from the decrease in fluorescence lifetime because this type of measurement is fairly impervious to drift and interference. Fluorescence intensities were measured remotely through fiber optics; however, this was only done when the load resistance in the detection circuit was large, such that the fluorescence decay reflected the RC time constant of the detection electronics rather than the fluorescence lifetime.

SR 91-02
SEA ICE OBSERVATIONS FROM THE WINTER WEDDELL GYRE STUDY-'89.
Meese, D.A., et al, Feb. 1991, 161p., ADA-236 036, With map notations in Russian.
Govoni, J.W., Churun, V., Ivanov, B., Komarovskiĭ, V., Shil'nikov, V., Zachek, A.
45-2903
MAPS, SEA ICE, ICE COVER THICKNESS, ICE CONDITIONS, ICEBERGS, ANTARCTICA—WEDDELL SEA.
The data for this report were obtained during the Winter Weddell Gyre Study-'89 from the Soviet icebreaker *Akademik Fedorov*. This study took place between Sep. and Nov. 1989 in the Weddell Sea. Several times each day throughout the cruise, notes were taken on the ice conditions that the ship was passing through at that time. These notes included ice concentration, thickness, ice type, amount of ridging, number of icebergs in the area and other distinguishing characteristics. In addition, photos of the area were taken and are included in the next section. The following section includes detailed ice observations maps. These maps contain information for every mile of ice that was passed through during the cruise, including ice thickness, type and concentration; iceberg size, number and type; and the extent and size of leads. Every 30-60 miles during the cruise stops were made at ice stations where ice cores and water samples were taken for physical and chemical studies, ice thickness grids were drilled, and optical measurements were made. At each site an ice map of the station was compiled, including wind direction and speed, air temperature, ice type, ice thickness and other characteristics of the area. Copies of these maps are found in the *Ice Station Maps* section. Also presented here are daily satellite photos of the area the ship was traversing. Throughout the cruise these photos provided the ship's crew with information regarding ice conditions that the ship would be encountering. The final section consists of weekly ice extent maps of the Weddell Sea obtained from the National Oceanographic and Atmospheric Administration. This report contains a complete observational analysis of the ice conditions encountered during this study in the Weddell Sea. (Auth. mod.)

SR 91-03
IN-SITU HEAT FLUX MEASUREMENTS IN BUILDINGS; APPLICATIONS AND INTERPRETATIONS OF RESULTS.
Flanders, S.N., ed, Feb. 1991, 260p., ADA-234 924, Refs. passim. Papers presented at the Workshop on In-Situ Heat Flux Measurements in Buildings, Hanover, NH, May 22-23, 1990. For individual papers see 45-2649 through 45-2662.
45-2648
BUILDINGS, HEAT FLUX, TEMPERATURE MEASUREMENT, THERMAL INSULATION, THERMAL CONDUCTIVITY.

SR 91-04
COMPARISON OF HEADSPACE GAS CHROMATOGRAPHY WITH EPA SW-846 METHOD 8240 FOR DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN SOIL.
Hewitt, A.D., et al, Feb. 1991, 7p., ADA-235 497, 13 refs.
Miyares, P.H., Leggett, D.C., Jenkins, T.F.
45-2826
SOIL POLLUTION, SOIL CHEMISTRY, CHEMICAL ANALYSIS, WASTE TREATMENT.
This study compares the levels of volatile organic compounds (VOCs) in a laboratory-prepared soil as determined by headspace gas chromatography and the EPA SW-846 purge and trap gas chromatography/mass spectrometry method (Method 8240). Vapor exposure was chosen as the method of contaminating the soil with trans-1,2-dichloroethylene, benzene, tricholoethylene and toluene. Preliminary results showed that the concentrations of the four compounds determined by the two analytical procedures were not significantly different at the 95% confidence interval for two levels of contamination. These findings indicate that headspace gas chromatography may have significant potential for hazardous waste assessment and cleanup programs.

SR 91-05
INTERNATIONAL STATE-OF-THE-ART COLLOQUIUM ON LOW-TEMPERATURE ASPHALT PAVEMENT CRACKING.
Scherocman, J.A., Feb. 1991, 50p., ADA-233 663, 45 refs.
46-4463
BITUMENS, LOW TEMPERATURE RESEARCH, COLD WEATHER PERFORMANCE, PAVEMENTS, CRACKING (FRACTURING), BITUMINOUS CONCRETES, BIBLIOGRAPHIES.
The International State-of-the-Art Colloquium on Low-Temperature Asphalt Pavement Cracking was held in Hanover, NH, on May 6-8, 1987. The objective was to review and summarize the existing knowledge of the causes of low-temperature transverse cracking of asphalt concrete pavement. Discussion also suggested directions for future research needed to more fully understand the mechanisms of low-temperature cracking. Overlays were not discussed.

SR 91-07
DEVELOPMENT OF A FIELD SCREENING METHOD FOR RDX SOIL.
Walsh, M.E., et al, June 1991, 21p., ADA-239 106, 20 refs.
Jenkins, T.F.
46-43
SOIL POLLUTION, SAMPLING, SOIL CHEMISTRY, EXPLOSIVES, LABORATORY TECHNIQUES, SOIL ANALYSIS, CHEMICAL ANALYSIS, CHEMICAL PROPERTIES.
CRREL has developed laboratory procedures to detect and quantify nitroaromatic and nitramine explosives in environmental samples. As with all methods used to detect contaminants in the environment, most of the samples analyzed prove to be blank. A more economical approach would be to screen a large number of samples on-site and to use the results to select samples for more in-depth laboratory analysis. TNT (2,4,6-trinitrotoluene) and RDX (hexhydro-1,3,5-trinitro-1,3,5,-triazine) are the two explosives most commonly found in munitions-contaminated soils. Jenkins (1990) developed a field screening method to detect TNT in soil. This report will describe a complementary procedure for detection of RDX.

SR 91-08
SIMULATION OF OIL SLICK TRANSPORT IN GREAT LAKES CONNECTING CHANNELS: USER'S MANUAL FOR THE MICROCOMPUTER-BASED INTERACTIVE PROGRAM.
Yapa, P.D., et al, July 1991, 31p., ADA-241 013, 3 refs.
Thomas, R.J., Jr., Rutherford, R.S., Shen, H.T.
46-784
OIL SPILLS, COMPUTERIZED SIMULATION, RIVER FLOW, LAKES, COMPUTER PROGRAMS, ICE COVER EFFECT, GREAT LAKES.
The growing concern over the impacts of oil spills on aquatic environments has led to the development of many computer models for simulating the transport and spreading of oil slicks in surface water. Almost all of these models were developed for coastal environments. In this study, two computer models, named ROSS and LROSS, were developed for simulating oil slick transport in rivers and lakes, respectively. This report explains how to use the microcomputer-based versions of these two models.

SR 91-09
MANAGEMENT OF VEGETATION ON AMMUNITION MAGAZINES AT AMC FACILITIES.
Palazzo, A.J., et al, June 1991, 24p., ADA-241 309.
Racine, C.H., Woodson, W., Pidgeon, D.E., Cate, D.W.
46-1049
MILITARY FACILITIES, VEGETATION, EARTHWORK, STORAGE.
The purpose of this study is to report the results of a survey of Army Materiel Command (AMC) facilities to assist in developing strategies for managing vegetation on ammunition bunkers or igloos. The survey questions addressed the number of igloos managed, the climate, the soils, and the types of vegetation managed. A total of 36 facilities located in 28 states were surveyed. These facilities manage 18,624 bunkers. The vegetation dominating the bunker surfaces varies according to the climate and location of the facilities. Soil types also vary widely. All respondents said that igloos provide important wildlife habitat. Vegetation management practices varied; mowing and herbicide use are common, and annual management expenses are mostly less than $300 per igloo.

SR 91-10
PRE-CONFERENCE ABSTRACTS.
Symposium on the Tropospheric Chemistry of the Antarctic Region, Boulder, CO, June 3-6, 1991, June 1991, 66p., ADA-236 274, Abstracts only.
Hogan, A.W., ed, Bowen, S.L., ed.
45-2918
ATMOSPHERIC COMPOSITION, AEROSOLS, AIR POLLUTION, OZONE, SNOW IMPURITIES, ICE COMPOSITION, ANTARCTICA.

SR 91-11
OPERATORS MANUAL FOR DETERMINING MOLE PERCENT PURITY USING IMPURE.
Pidgeon, D., et al, Aug. 1991, 33p., ADA-242 592, 12 refs.
Black, P.B.
46-1865
MANUALS, COMPUTER PROGRAMS, LABORATORY TECHNIQUES, DATA PROCESSING, FREEZING POINTS, TEMPERATURE MEASUREMENT, STANDARDS.
This report presents the laboratory procedures and operation of the computer program IMPURE, which allows the operator to measure the mole percent purity of Standard Analytical Reference Materials (SARMs). Melting point temperature, freezing point depression and heat of fusion are measured by differential scanning calorimetry (DSC). These data are then used in van't Hoff's equation to determine molar purity. IMPURE was written to control the operation of the DSC and the analyses of the collected data according to American Society of Testing and Materials (ASTM) standards.

SR 91-12
IONPAIR: A CHEMICAL SPECIATION PROGRAM FOR CALCAREOUS AND GYPSIFEROUS SOIL SOLUTIONS.
Marion, G.M., Sep. 1991, 12p., ADA-242 593, 16 refs.
46-1866
SOIL CHEMISTRY, CHEMICAL COMPOSITION, SOIL WATER, COMPUTER PROGRAMS.
The IONPAIR program was designed to speciate the chemical composition of calcareous and gypsiferous soil solutions. The program uses the Newton-Raphson algorithm to solve by successive approximations a set of non-linear equations relating ionic concentrations and activities. This program allows the user to specify as input any two of the following three variables: pH, alkalinity and P(CO2). This flexibility allows one to check the internal consistency of experimental measurements, equilibrium constants and model assumptions. For example, is total alkalinity equal to inorganic carbon alkalinity? IONPAIR was designed as a "stand-alone" program, which means that it is easily usable and is available in both Macintosh and MS-DOS versions.

SR 91-13
ROLE OF DONOR-ACCEPTOR INTERACTIONS IN THE SORPTION OF TNT AND OTHER NITROAROMATICS FROM SOLUTION.
Leggett, D.C., Sep. 1991, 8p., ADA-243 235, Refs. p.5-8.
46-1867
EXPLOSIVES, SOIL CHEMISTRY, SOIL POLLUTION.
The evidence related to sorptive interactions of nitroaromatics is reviewed. Although evidence from a variety of organic model systems suggests that sorptive interaction of nitroaromatics with organic components will occur, the statistical evidence attributes greater importance to inorganic components over organic matter in soil sorption of TNT. It was concluded that donor-acceptor interactions are more important than purely hydrophobic effects in the sorption of nitroaromatics from solution onto soils and model sorbents. Furthermore, TNT in soil-water systems may become an ultimate recipient of charge, causing its reductive transformation and subsequent covalent bonding to soil organic matter components.

SR 91-14
ICE FORCE MEASUREMENTS ON A BRIDGE PIER IN THE ST. REGIS RIVER, NEW YORK.
Haynes, F.D., et al, Oct. 1991, 6p., ADA-249 504, 10 refs.
46-3999
RIVER ICE, MEASURING INSTRUMENTS, ICE FLOES, PIERS, DESIGN CRITERIA, ICE SOLID INTERFACE.
An ice force panel was installed on the upstream nose of a pier of the new (1989) bridge over the St. Regis River at Hogansburg, NY. This panel is a simply supported beam, pinned at the bottom, and has a load cell for the reaction at the top. Ice forces measured with this panel during the Mar. 16, 1990 ice run are presented. Ice failed against the panel by impact, by crushing and possibly by splitting of the floes.

SR 91-15
USER'S MANUAL FOR ESTK1D.FOR AND ESTK2S.FOR WAVENUMBER ESTIMATION ROUTINES.
Moran, M.L., Oct. 1991, 15p., ADA-244 099, 7 refs.
46-1868
MANUALS, COMPUTER PROGRAMS.
This document describes the operation and structure of the Fortran programs ESTK1D.FOR and ESTK2D.FOR. These frequency domain wavenumber estimation programs implement either the Bartlett or the high-resolution Capon (1969) maximum-likelihood beamformers. The program ESTK1D.FOR forms a beam response based on a one-dimensional observation wavenumber that is rotated through wavenumber space to determine the spatial bearing of a plane wave source. ESTK2D.FOR uses the beam response in two-dimensional wavenumber space to estimate the two-dimensional wavenumber vector of a plane wave source. The discussion presented in this paper focuses on the operational details of installing and running ESTK1D and ESTK2D.

SR 91-16
ONE-DIMENSIONAL TEMPERATURE MODEL FOR A SNOW COVER; TECHNICAL DOCUMENTATION FOR SNTHERM.89.
Jordan, R., Oct. 1991, 49p., ADA-245 493, Refs. p.46-49.
46-2565
MATHEMATICAL MODELS, SNOW COVER, MASS BALANCE, SNOW COMPACTION, COMPUTERIZED SIMULATION, FLUID FLOW, PHASE TRANSFORMATIONS, METAMORPHISM (SNOW), FROZEN GROUND MECHANICS.
This report provides technical documentation for the computer code SNTHERM.89, which is a one-dimensional mass and energy balance model of snow and frozen soil. The model is structured using a simplified mixture theory and addresses coupled mass and heat flow, phase change and snow metamorphism. The underlying theory and numerical equations are presented. Included are detailed descriptions of the computation of the energy fluxes at the air/snow interface and of optional routines for estimating short- and long-wave radiation on horizontal and sloped surfaces.

SR 91-17
FIELD SCREENING METHOD FOR 2,4-DINITROTOLUENE IN SOIL.
Jenkins, T.F., et al, Oct. 1991, 11p., ADA-245 492, 12 refs.
Walsh, M.E.
46-2566
SOIL POLLUTION, EXPLOSIVES, MILITARY OPERATION.
A simple field screening method was developed to detect the presence of 2,4-dinitrotoluene (2,4-DNT) in soil. The method involves extraction of 2,4-DNT from the soil with acetone, generation of a bluish-purple Janowsky complex by addition of potassium hydroxide and sodium sulfite, and estimation of concentration by measuring the absorbance at 570 nm with a battery-operated spectrophotometer. While the extent of color development is also somewhat dependent on the moisture content of the soil, analysts can visually detect concentrations of 2 micrograms per gram or greater in the soil. The acetone extraction step was shown to extract at least 80% of the 2,4-DNT present in a series of field contaminated soils. A 30-minute reaction time is required after addition of the reagents, and the color, once formed, is stable for at least 60 minutes after filtration. The presence of TNT, tetryl, TNB and 2,6-DNT will result in a positive interference with this method. High concentrations of copper in the soil may result in negative interference by inhibiting the formation of the Janowsky complex or by complexing with it to modify its visual absorbance characteristics.

SR 91-18
IMPROVED SALTING OUT EXTRACTION-PRECONCENTRATION METHOD FOR THE DETERMINATION OF NITROAROMATICS AND NITRAMINES IN WATER.
Miyares, P.H., et al, Oct. 1991, 39p., ADA-245 491, 40 refs.
Jenkins, T.F.
46-2564
EXPLOSIVES, WATER POLLUTION, MILITARY OPERATION, WATER CONTENT, GROUND WATER, LABORATORY TECHNIQUES.
An improved salting-out extraction-preconcentration, RP-HPLC-UV protocol for the determination of nitroaromatics and nitramines in water was developed. The method involves saturating a 760-mL water sample with NaCl and extracting with acetonitrile (ACN). Collected extracts are then preconcentrated and solvent exchanged to water via a Kuderna-Danish evaporator. Analysis involves solute focusing by introducing an 1100-mL sample onto a LC-8 (7.5-cm, 3-micron) column eluted with water, MeOH and THF (70.7:27.8:1.5[v/v/v]) at 2.0 mL/min followed by UV detection at 254 nm. A direct injection RP-HPLC-UV water method was developed concurrently, employing the same separation and detection techniques. Both methods are applicable for simultaneous determination of RDX, TNB, DNB, 2,4-DNT, 2,6-DNT, 2- Am-DNT and 4-Am-DNT, and HMX (salting-out only) with reporting limits ranging from 0.006 to 0.27 micrograms/L for the salting- out method and 0.12 to 1.07 micrograms/L for the direct injection method. The salting-out extraction procedure is suitable for determination of HMX, RDX, TNT, 2,4-DNT and 2,6-DNT at concentrations below the health advisory and water quality criteria proposed by the USEPA and Oak Ridge National Laboratory.

SR 91-19
FIELD MEASUREMENTS OF HEAT LOSSES FROM THREE TYPES OF HEAT DISTRIBUTION SYSTEMS.
Phetteplace, G.E., et al, Nov. 1991, 33p., ADA-247 460, 12 refs.
Kryska, M.J., Carbee, D.L.
46-2918
HEAT LOSS, TEMPERATURE MEASUREMENT, HEAT PIPES, HEATING, HEAT FLUX, THERMAL INSULATION, THERMOCOUPLES, ANALYSIS (MATHEMATICS).
The actual level of heat losses from operating heat distribution systems is not well known. The effect of the type of distribution system and the length of time in service in heat losses are also not known, and methods used to calculate heat losses have not been adequately verified. This report describes a field project at Ft. Jackson, SC, which addresses these needs. At Ft. Jackson three different types of systems have been instrumented: shallow concrete trench, steel conduit with supply and return in common conduit, and separate conduits for supply and return pipes. The heat losses from these systems are being monitored using several methods. Data have been collected from these sites for over four years, and some of the initial results are presented.

SR 91-21
AN ANALYSIS OF THE STRESS WAVE IN SOLIDS (SWIS) FINITE ELEMENT CODE.
Faran, K.J.L., Nov. 1991, 32p., ADA-245 921, 6 refs.
46-2567
WAVE PROPAGATION, STRESSES, MATHEMATICAL MODELS, COMPUTER PROGRAMS.
The Stress Wave in Solids (SWIS) finite element code is a versatile program in that it can solve problems in one, two or three spatial dimensions. Although the code assumes linear elasticity and isotropic materials, it can solve problems in regions containing up to 9 different material types. To demonstrate its utility, SWIS has been used to solve 3 classical wave propagation problems: one-dimensional longitudinal displacement, impulse along the length of a cantilevered beam and Lamb's problem. This report describes how to use SWIS by summarizing the contents of the input and output files. Discussions of damping factors, computation times and comparisons to other solutions are also included.

SR 91-23
HISTORICAL PERSPECTIVES IN FROST HEAVE RESEARCH: THE EARLY WORKS OF S. TABER AND G. BESKOW.
Black, P.B., ed, Dec. 1991, 169p., ADA-247 395, Refs. passim.
Hardenberg, M.J., ed.
46-2917
FROST HEAVE, SOIL PHYSICS, PAVEMENTS, SOIL FREEZING, HOARFROST, SOIL MECHANICS, ROADS, RAILROADS, HISTORY, ANALYSIS (MATHEMATICS), PERMEABILITY, CAPILLARITY, TEMPERATURE GRADIENTS, GROUND WATER.
This report contains a historical perspective of frost heave research conducted in North America and Europe since the early 1900s, and, in the interest of making some classic works on the mechanics of frost heave available in one document, Stephen Taber's two papers entitled *Frost Heaving* (1929) and *The Mechanics of Frost Heaving* (1930) published in the *Journal of Geology*, and J.O. Osterberg's translation of Gunnar Beskow's monograph, *Soil Freezing and Frost Heaving with Special Attention to Roads and Railroads* (1935).

SR 91-24
POTENTIAL AIRFIELD SITES IN ANTARCTICA FOR WHEELED AIRCRAFT.
Swithinbank, C., Dec. 1991, 68p., ADA-249 503, 16 refs.
46-5162
ICE RUNWAYS, SITE SURVEYS, AERIAL SURVEYS, SITE ACCESSIBILITY, LOGISTICS, AIRPLANES, ANTARCTICA.
This is a report on a search for possible or potential airfield sites in Antarctica, using aerial photographs and satellite images supplemented by other data. A few sites are on ice-free ground but the majority are on inland blue ice fields. Earlier studies of potential airfields on antarctic glacier ice are referenced. The attraction of a well-chosen blue-ice runway is that construction and maintenance costs are almost nil. A number of sites have been found suitable for the operation of unmodified transport aircraft on wheels. An inland icefield site on Mill Glacier is in use for wheel landings by LC- 130 aircraft; another at Patriot Hills is in use for wheel landings by DC-6 aircraft. (Auth.)

SR 91-26
DECONTAMINATION IN THE COLD USING DRY POWDERS; STUDIES WITH CHEMICAL AGENT SIMULANTS.
Heeremans, M.F., et al, Dec. 1991, 18p., ADB-162 262, 19 refs.
Parker, L.V.
46-2920
COLD WEATHER OPERATION, COLD WEATHER PERFORMANCE, MILITARY OPERATION.
Current U.S. Army procedures for decontaminating surfaces that have been contaminated with chemical warfare agents utilize chemical neutralization techniques that involve using liquids at subfreezing temperatures and also usually involve using water rinses. Because of the obvious problems associated with using water or any liquid at subfreezing temperatures, this report examines using absorbent powders for decontamination at low temperatures. Wiping contaminated surfaces with paper towels was compared with applying a dry powder and then wiping it off. Four powders (Fuller's earth, sand, garden soil, and talc) were tested on both clean and dirty painted and unpainted surfaces at temperatures as low as -29 C. Two chemical agent simulants were used for this portion of the testing: a neat agent simulant (BIS) and a thickened agent simulant (tDEM). Generally, these decontamination procedures became much more effective at low temperatures than they were at room temperature. A relatively quick procedure for decontaminating smaller equipment was developed using Fuller's earth.

SR 91-27
USE OF SCRAP RUBBER IN ASPHALT PAVEMENT SURFACES.
Eaton, R.A., et al, Dec. 1991, 14p., ADA-249 505, 14 refs.
Roberts, R.J., Blackburn, R.R.
46-3552
TIRES, BITUMENS, RUBBER, ROAD ICING, CONCRETE PAVEMENTS, RUBBER ICE FRICTION.
Scrap tire rubber was mixed into an asphalt concrete wearing course to study the effect of ice disbonding from the pavement surface under traffic. Rubber contents of 0, 3, 6, and 12% by weight were studied. Initial laboratory ice disbonding test results led to the development of a new paving material, Chunk Rubber Asphalt Concrete (CRAC), that uses larger pieces of rubber in a much denser asphalt concrete mix. Strength values doubled and ice disbonding performance was enhanced.

SR 91-28
TESTING OF A DEICING FLUID FOAM FORMULATION FOR DECONTAMINATION AT LOW TEMPERATURES.
Walsh, M.E., et al, Dec. 1991, 6p., ADB-162 209, 8 refs.
Parker, L.V.
46-2922
ICE REMOVAL, ICE PREVENTION, AIRCRAFT ICING, LOW TEMPERATURE TESTS, COLD WEATHER PERFORMANCE, COLD WEATHER OPERATION, ANTIFREEZES.
Several foam formulations have been tested for feasibility as hasty decontaminants, and as a possible alternative to conventional chemical decontaminants. At higher ambient temperatures, foam decontaminants offer several advantages: they adhere well to vertical surfaces and they are thicker than conventional decontaminants, and thus can offer a barrier to agent desorption. They also are less logistically demanding and less damaging to materials than DS2. This report focusses on the use of one of these foam decontaminants (Reformulated Aircraft Deicing Fluid or RADF) for use at subfreezing temperatures. Tests run at -29 C revealed that this formulation is not a suitable alternative to DS2. The primary problem was that the components used to make it were frozen at this low temperature. While the components could be previously mixed at higher temperatures, these mixtures would either freeze or separate upon cooling. The amount of antifreeze added to the formulation could be increased to prevent freezing, but this did not yield an acceptable product. DS2 appears to be a much better product to use at subfreezing temperatures.

SR 91-29
SIMULATION OF OIL SLICK TRANSPORT IN GREAT LAKES CONNECTING CHANNELS: USER'S MANUAL FOR THE RIVER OIL SPILL SIMULATION MODEL (ROSS).
Shen, H.T., et al, Dec. 1991, 94p., ADA-247 845, 6 refs.
Yapa, P.D., Petroski, M.E.
46-2919
MODELS, COMPUTERIZED SIMULATION, OIL SPILLS, CHANNELS (WATERWAYS), ICE COVER EFFECT, ENVIRONMENTAL IMPACT, ICE CONDITIONS, RIVER FLOW.
The growing concern over the impacts of oil spills on aquatic environments has led to the development of many computer models for simulating the transport and spreading of oil slicks in surface water. Almost all of these models were developed for coastal environments. In this study, two computer models, named ROSS and LROSS, were developed for simulating oil slick transport in rivers and lakes, respectively. This report explains how to use ROSS.

SR 91-30
NOTES FOR COLD WEATHER MILITARY OPERATIONS.
Richmond, P.W., ed, Dec. 1991, 58p., ADB-162 421, 32 refs.
46-3039
MILITARY OPERATION, LOGISTICS, WATER SUPPLY, COLD WEATHER SURVIVAL, COLD WEATHER OPERATION, SNOW (CONSTRUCTION MATERIAL).
The effect of cold weather on personnel and equipment must be considered during planning and preparing for military operations. A large amount of information and a number of special techniques have been developed at CRREL for conducting operations in the cold. Much of this information has been incorporated into Army doctrine as doctrinal publications have been updated or rewritten. The purpose of this report is to provide a fairly comprehensive compilation of cold weather operational procedures and techniques and to consolidate, in one place, recent achievements that are not published in a doctrinal source. This report is divided into two parts. Part 1 contains current U.S. Army operational doctrine; excerpts of cold weather doctrine are presented for operations that are particularly sensitive to cold regions effects. Part 2 is a compilation of knowledge from other sources, particularly from research programs conducted by the CRREL, to provide further information on special techniques and methodologies for conducting military operations in the cold. The following broad areas are discussed —planning, mobility, countermobility, survivability, decontamination, water supply and communications.

SR 91-31
CREEP AND YIELD MODEL OF ICE UNDER COMBINED STRESS.
Fish, A.M., Dec. 1991, 14p., ADA-249 788, 36 refs.
46-3553
ICE MODELS, ICE CREEP, COMPRESSIVE PROPERTIES, STRESS STRAIN DIAGRAMS, MATHEMATICAL MODELS, ICE DEFORMATION.
Constitutive equations and strength criteria have been developed for ice in a multiaxial stress state. The equations developed describe the entire creep process, including primary, secondary, and tertiary creep, at both constant stresses and constant strain rates in terms of normalized (dimensionless) time. Secondary creep is considered an inflection point defining the time to failure. The minimum strain rate at failure is described by a modified Norton-Glen power equation, which, as well as the time to failure, includes a parabolic yield criterion. The yield criterion is selected either in the form of an extended von Mises-Drucker-Prager or an extended Mohr-Coulomb rupture model. The criteria take into account that at a certain magnitude of mean normal stresses the shear strength of ice reaches a maximum value due to local melting of ice. The model has been verified using test data on the yield of polycrystalline ice at -11.8 C and on creep of saline ice at -5 C, both under triaxial compression.

SR 92-01
JOINT UNITED STATES-CANADIAN OBSCURATION ANALYSIS FOR SMOKES IN SNOW (JUSCAN OASIS): SMOKE WEEK XI DATA REPORT.
Perron, F.E., Jr., ed, Jan. 1992, 106p., ADB-162 747, 2 refs.
Hardenberg, M.J., ed.
46-3038
MILITARY OPERATION, MILITARY EQUIPMENT, COLD WEATHER OPERATION, SNOWFALL, SNOW SURFACE TEMPERATURE, SNOW PHYSICS, SNOW COVER EFFECT, STATISTICAL ANALYSIS.
The Smoke Week XI field trials were conducted jointly by the United States and Canadian governments at the Defense Research Establishment Valcartier (DREV), Quebec, Canada, during Feb.-Mar. 1989. The Project Manager, Smoke/Obscurants (PM Smoke), and the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) were the U.S. sponsoring organizations, while other government agencies and contractors cooperated. The objectives of the field study were to 1) determine the effects of cold weather and falling snow on electro-optical and laser weapon systems with and without obscurants, 2) study the synergistic effects of snow and the dissemination of smoke and obscurants, 3) extend to cold and snow conditions the search, detection and acquisition study objectives of Smoke Week X conducted at Fort Huachuca, AZ, during Sep.-Oct. 1988, 4) assess under cold climatic conditions the field performance of inventory and developmental visual and infrared screening materials, and 5) acquire data on the effects of smokes and obscurants on target contrasts in snow environments. This data report presents information gathered at Smoke Week XI by CRREL personnel, including field data collected on meteorology, snow characterization and atmospheric propagation.

SR 92-02
ON THE USE OF AN ARTIFICIAL SNOW PLATFORM FOR WAM TESTS.
Albert, D.G., Jan. 1992, 11p., ADA-247 868, 8 refs.
46-2916
MILITARY OPERATION, MINES (ORDNANCE), SNOW (CONSTRUCTION MATERIAL), SNOW ACOUSTICS, WAVE PROPAGATION, SOUND WAVES.
An experiment was conducted to test the effectiveness of using a small platform constructed of packed snow to simulate the effects of a snow cover on ground sensors used in vehicle detection and identification. A simple impulsive acoustic source (.45-caliber pistol firing blanks) was used to simplify the interpretation of the experimental measurements. Geophones and microphones on the snow platform and on undisturbed snow nearby were used to record the signals. These measurements show no significant difference between signals recorded on the snow platform and on the surrounding undisturbed snow. Consideration of previous measurements and acoustic theory shows that the platform would have to be much larger in areal extent to affect the recorded signatures; it is the interaction of the acoustic waves with the ground surface over their entire propagation path that controls the properties of the signal at the ground sensor.

SR 92-03
TESTS IN ICE ON AN ANTARCTIC RESEARCH VESSEL MODEL.
Tatinclaux, J.-C., Feb. 1992, 41p., ADA-249 789, 6 refs.
46-3554
SHIPS, ICEBREAKERS, DESIGN, MODELS, PRESSURE RIDGES, TESTS.
A new antarctic research vessel to be chartered by the National Science Foundation was designed and is under construction by North American Shipbuilding, Inc., Larose, LA. A full model test program was required by NSF to verify that the proposed design would meet the vessel operational requirements. In particular, the ship is to break 3 ft (0.9 m) of ice at 3 kn (1.5 m/s) continuously and break through pressure ridges with a 6 ft (1.8 m) sail and a 20 ft (6.1 m) keel. Ice model tests were made in CRREL's ice towing tank. The test program included resistance and propulsion tests in level ice, tests in ridges and ramming tests in ice floes of up to 6 ft (1.83 m) in thickness. The test results described in the report indicate that the proposed ship design with 8.8 MW of power available at the propeller would meet or exceed all operational requirements in ice. The power needed to operate continuously in 3 ft first year level ice at 3 kn was estimated at 6.5 MW; the vessel was found to be able to ram through a 38 ft (11 m) keel ridge; finally, when ramming in 6 ft thick level ice at an impact speed of 6 kn (3.1 m/s) at full power, the vessel was predicted to penetrate by about one-third of a ship length into the ice. (Auth.)

SR 92-04
EVALUATION OF A PNEUMATIC GUY-LINE DEICING BOOT.
Govoni, J.W., et al, Feb. 1992, 7p., ADA-252 013, 2 refs.
Franklin, C.H.
46-4053
ICING, ICE LOADS, ICE PREVENTION, ICE REMOVAL.
During the two winter field seasons of 1986-88, a 3 m-long pneumatic cable deicing boot was tested and evaluated by CRREL at the summit of Mt. Washington, NH. Favorable results from this pilot study led to the development of a longer (14 m) pneumatic boot. This longer boot, which was used to entirely encase one of the guy lines supporting a 9 m-high tower, was evaluated at the summit of Mt. Washington during the 1987-88 icing season. The performance of both pneumatic cable deicing boots during a variety of icing conditions indicates that this simple, cost-effective method of ice prevention on guy wires may be suitable for practical application.

SR 92-05
0.45- TO 1.1-MICRON SPECTRA OF PRUDHOE CRUDE OIL AND OF BEACH MATERIALS IN PRINCE WILLIAM SOUND, ALASKA.
Taylor, S., Apr. 1992, 14p., ADA-251 911, 14 refs.
46-4052
SPECTRA, OIL SPILLS, ENVIRONMENTAL IMPACT, ENVIRONMENTAL TESTS, POLLUTION.
The spectral response in the visible and near-infrared (wavelengths of 0.45 to 1.10 micron) of different amounts of Prudhoe crude oil on water was measured. Spectral reflectance measurements were made of selected beaches and beach materials in Prince William Sound to provide ground truth data for the MEIS II imagery collected during the *Exxon Valdez* spill. A spectral mixing model was used to predict how different amounts of oil would change the spectra of beach materials in Prince William Sound.

SR 92-06
SHIP ICING INSTRUMENTATION.
Walsh, M.R., et al, Apr. 1992, 40p., ADA-251 346, 3 refs.
Morse, J.S., Knuth, K.V., Lambert, D.J.
46-4051
SHIP ICING, ICE ACCRETION, SPRAY FREEZING, SEA SPRAY, DESIGN, ICE MODELS, MEASURING INSTRUMENTS.
To gather empirical data on ship superstructure icing upon which to base and verify a computer model that can be used to predict icing events, the U.S. Army Cold Regions Research and Engineering Laboratory was asked by the U.S. Navy David Taylor Ship Research and Development Center to create a prototype system capable of collecting relevant spray and icing data on ship decks during cold-weather cruises. The resulting ship icing instrumentation can be divided into two parts: a video system to obtain a visual record of spray and icing, and several stand-alone instrumented units to obtain quantitative data. The units are capable of measuring liquid water content of spray fluxes in either the horizontal or vertical directions, measuring ice accretion in either direction, and monitoring several other parameters such as temperature and power level. Problems associated with salt water rendered most of the spray data collected during a cruise aboard the USCGC *Midgett* unusable. Some problems with surface roughness may have degraded the ice thickness data. Otherwise, the equipment worked quite well. Further work on using a capacitance gauge to measure salt water levels needs to be conducted before the equipment is redeployed at sea.

SR 92-07
PRECISION ANALYSIS AND RECOMMENDED TEST PROCEDURES FOR MOBILITY MEASUREMENTS MADE WITH AN INSTRUMENTED VEHICLE.
Shoop, S.A., Apr. 1992, 47p., ADA-252 014, 10 refs.
46-4050
STATISTICAL ANALYSIS, ACCURACY, MEASURING INSTRUMENTS, VEHICLES, COLD WEATHER OPERATION.
This report addresses the precision of mobility measurements made using an instrumented vehicle. Systematic errors were documented and new techniques established to eliminate or minimize these errors. An increase in the precision and accuracy of mobility measurements will allow the successful pursuit of new research efforts of concern to cold regions mobility, such as the resistance measurements of trailing tires and terrain resistance on shallow snow or winter soils. Systematic errors due to calibration methods, temperature, vehicle speed and weight distribution were observed and quantified. Based on these results, suggested techniques to eliminate or minimize these errors and improve precision are as follows. 1) The method of calibration (air, static or rolling) should be chosen based on the objective of the experiment. Calibrating the vehicle while it is rolling yields the most consistent results from test to test; however, static calibration is needed to measure the total resistance of the vehicle running gear. 2) Because of the wide range of temperatures considered in cold regions testing and the temperature sensitivity of the equipment, the vehicle and all equipment should be operating and temperatures stabilized before vehicle calibration and testing begins. If the weather changes

significantly during the course of the tests, it should be noted and the vehicle should be recalibrated. 3) The vehicle must be on as level and smooth a surface as possible because the load on the wheels is extremely sensitive to weight distribution (and tilt) of the vehicle. Small variations in the weight distribution are also reflected in the contact area of the tires. 4) Mobility testing procedures should routinely include a hard surface motion resistance measurement for each set of test conditions to serve as a reference for the terrain mobility measurements and as a comparison between data sets.

SR 92-08

LASER DEPOLARIZATION FROM TARGETS IN A WINTER ENVIRONMENT.

Koh, G., Apr. 1992, 8p., ADB-164 886, 4 refs.

46-4370

LASERS, BACKSCATTERING, MINES (ORDNANCE), DETECTION, SNOW COVER EFFECT, ICE COVER EFFECT, FROST, COLD WEATHER OPERATION, MILITARY OPERATION.

The use of a near-infrared laser (1.06 micron wavelength) scanner for the standoff detection of surface mines is currently under consideration by the military. The concept is to rapidly scan a potential minefield with a polarized laser beam and to map the backscatter intensity and depolarization patterns from the scanned area in order to determine the presence of mines. Experiments have been conducted to investigate the potential limitations of such a system in a winter environment. Metal plates were coated with military-specified primer and paints to simulate mine surfaces, and the polarization-dependent reflectance properties of these surfaces were measured. Changes caused by the presence of frost, snow, ice and water on the reflectance properties of the simulated mine surfaces were determined. The mechanisms involved in the depolarization of the laser beam backscattered from these surfaces are discussed.

SR 92-09

SADARM CAPTIVE FLIGHT TESTS: 35-GHZ GROUND-BASED RADAR SYSTEM MEASUREMENTS.

Nagle, J.A., Apr. 1992, 59p., ADA-252 553, 2 refs.

46-4369

COLD WEATHER OPERATION, MILITARY OPERATION, BACKSCATTERING, ANALYSIS (MATHEMATICS), RADAR ECHOES, ANTENNAS, RADAR.

Search and Destroy Armaments (SADARM) winter captive flight tests were conducted in Grayling, MI, from Mar. 6-19, 1990 to assess the performance of SADARM sensors flying over appropriate target sets in a winter background environment. Several target configurations were used in a variety of winter conditions, including both moving and stationary targets as well as clean and countermeasured targets and decoys. Ground-based millimeter wave radar and infrared measurements made during the testing period provided data to increase the understanding of target-background interaction. This report contains the methods used to reduce and calibrate the ground-based 35-GHz radar data. Each scene imaged is described and a discussion is presented of the methods used to calculate the backscattered power and NRCS and to calibrate the radar.

SR 92-10

ACOUSTICALLY COUPLED GROUND MOTION UNDER CONTROLLED CONDITIONS: TRIAL STUDY.

Peck, L., Apr. 1992, 15p., ADA-252 384, 6 refs.

46-4368

FROZEN GROUND PHYSICS, SANDS, ACOUSTICS, ACOUSTIC MEASUREMENT, THERMOCOUPLES, LOW FREQUENCIES.

A series of ground-motion experiments was done in the Frost Effects Research Facility at CRREL in 1985 and 1986 to determine the suitability of the FERF for studies of ground motion induced by low-frequency acoustic sources. A special method of freezing the contents of a FERF test basin by circulating frigid air was effective in freezing sand to a depth of 53 cm. The reverse means of thawing the sand, exposing it to the ambient temperature air in the FERF, did not allow for expeditious warming of the sand during winter months. Acoustically coupled ground motion was measured for sand conditions of dry, unfrozen; dry, frozen; saturated; and hard frozen. Ground-motion amplitude was 30-40% lower in saturated sand than in dry, unfrozen sand. This depth-dependent reduction is attributed to reduced air permeability in the saturated sand. The amplitude of acoustically coupled ground motion in hard frozen sand (sand frozen when wet) was 80-90% lower than in dry, unfrozen sand.

SR 92-11

EFFECTS OF THE ABRASIVENESS OF TEST AND TRAINING SITE SOILS ON PARACHUTE LIFE.

Hogan, A.W., May 1992, 27p., ADA-252 389, 6 refs.

46-4367

MILITARY OPERATION, MILITARY EQUIPMENT, ABRASION, PARTICLE SIZE DISTRIBUTION, PHYSICAL PROPERTIES, DESERT SOILS, SOIL ANALYSIS, SANDS, ELECTRON MICROSCOPY.

Soil samples collected at proving grounds, test sites and paratroop training areas were examined in an attempt to estimate their potential abrasive properties when in contact with parachute support lines. Portions of support lines that had been invaded by grit during strain tests were also examined to determine the properties of the particles that degraded the lines. These preliminary analyses indicate that soil particles of a size comparable to that of the individual filaments of the parachute cord infiltrate to the interior of the cord, become embedded and damage the cord. It is necessary to determine some additional soil properties, most importantly effective hardness of the individual grains, to establish a general description of performance degradation.

SR 92-14

PASSIVE TECHNIQUES FOR MANIPULATING FIELD SOIL TEMPERATURES.

Marion, G.M., et al, June 1992, 11p., ADA-254 303, 8 refs.

Pidgeon, D.E.

46-5318

SOIL TEMPERATURE, GLOBAL CHANGE, CLIMATIC CHANGES, FROZEN GROUND TEMPERATURE.

Recent concerns about global climate change have focused attention on the methodology for manipulating field soil temperatures. The objective of this study was to evaluate several simple, inexpensive, passive systems for changing soil surface temperature in the field. Four classes of treatments were evaluated, including plastic ground covers, fabric ground covers, fabric greenhouses, and open-top chambers. In general, treatments raised daytime maximums and lowered nighttime minimums. In some cases these opposite effects balanced, and there was no change in mean daily temperature. Five treatments changed mean daily temperature by at least +/- 1.0 C; these included black plastic (-2.6 C), two clear plastic treatments (+1.0 C), Reemay greenhouses (+1.0 C), and Reemay ground covers (+2.4 C). A multiple linear regression analysis of maximum temperatures indicated that the temperature differential between treatment and control plots was most strongly controlled by solar radiation >time>wind speed. Differences among treatments were greatest on sunny days and minimal on rainy days. Both the present study and previous studies suggest that these passive systems can alter mean daily soil surface temperatures by, at most, +/- 2.5 C.

SR 92-15

DIGGING FROZEN GROUND WITH A RIPPER BUCKET.

Sellmann, P.V., et al, June 1992, 9p., ADA-254 304, 10 refs.

Brockett, B.E.

46-5316

EXCAVATION, COLD WEATHER CONSTRUCTION, CONSTRUCTION EQUIPMENT, FROZEN GROUND STRENGTH.

To improve the digging capability of small excavators and backhoes in hard and frozen ground, a bucket of special design was selected from among a variety of attachments. This bucket cuts and rips the frozen ground, as lip teeth and a set of staggered teeth attached to the back of the bucket move through an arc during bucket rotation. Digging observations were made using a small mini-excavator and an Army tractor (SEE) with a rear-mounted backhoe. Frozen ground was excavated at several sites under conditions impossible for a conventional bucket. A large variation in excavation rates (3 to 30 cu yd/hr [2.3 to 23 cu m/hr]) was observed, depending on material type, frost thickness, sharpness of the cutters and operator experience.

MONOGRAPHS

M 90-03
SNOW ROADS AND RUNWAYS.
Abele, G., Nov. 1990, 100p., ADA-231 490, Refs. p.88-98.
45-1971
SNOW ROADS, RUNWAYS, SNOW STRENGTH, TRAFFICABILITY, SNOW COMPACTION, SNOW (CONSTRUCTION MATERIAL), ANALYSIS (MATHEMATICS).
This monograph presents a complete review of all successful techniques that have been used to construct and maintain snow roads, trails and aircraft landing strips. The snow properties that must be considered prior to the construction process are identified, and the kinds of apparatus available for the measure of the properties are reviewed and assessed. A discussion of construction techniques is presented, which includes the types of snow pavements, the classification of roads by use, the classification of surface and subsurface strength, the considerations impacting on site selection, the various kinds of equipment that have been developed to construct and maintain the roads, and the additives that have been used to construct high-strength roads. The design criteria that have been established are cited.

M 90-04
NATURAL CONVECTION HEAT TRANSFER IN WATER NEAR ITS DENSITY MAXIMUM.
Yen, Y.C., Dec. 1990, 92p., ADA-233 106, 42 refs.
45-2237
ICE WATER INTERFACE, HEAT TRANSFER, PHASE TRANSFORMATIONS, CONVECTION, WATER, ANALYSIS (MATHEMATICS), TEMPERATURE EFFECTS, HYDRODYNAMICS, DENSITY (MASS/VOLUME).
This monograph reviews and summarizes to date the experimental and analytical results on the effect of water density near its maximum on convection, transient flow and temperature structure characteristics: 1) in a vertical enclosure; 2) in a vertical annulus; 3) between horizontal concentric cylinders; 4) in a square enclosure; 5) in a rectangular enclosure; 6) in a horizontal layer; 7) in a circular confined melt layer; and 8) in bulk water during melting. In a layer of water containing a maximum density temperature of 4 C, the onset of convection (the critical number) is not a constant value as in the classical normal fluid but one that varies with the imposed thermal and hydrodynamic boundaries. In horizontal layers, a nearly constant temperature zone forms and continuously expands between the warm and cold boundaries. A minimum heat transfer exists in most of the geometries studied and, in most cases, can be expressed in terms of a density distribution parameter. The effect of this parameter on the formation, disappearance, and transient structure of a cell is discussed, and the effect of split-boundary flow on heat transfer is presented.

M 92-01
EUROPEAN FOUNDATION DESIGNS FOR SEASONALLY FROZEN GROUND.
Farouki, O.T., Mar. 1992, 113p., ADA-250 833, 51 refs.
46-4001
FROST HEAVE, FOUNDATIONS, DESIGN, FROZEN GROUND MECHANICS, COLD WEATHER CONSTRUCTION.
The report deals with the design of foundations against frost action in Europe, particularly as practiced in the Nordic countries. It describes how insulation is used in association with foundations of structures as part of a process of thermal engineering to produce safe and economic designs for various structures. The use of insulation enables heat management that allows shallower foundation depths and prevents damage from frost action. Results are given from the Norwegian Frost I Jord research project and the work at Lund University, Sweden, both of which provided the basis for the design guidelines of Norway, Sweden and Finland. Detailed slab-on-grade designs ensure that frost heave does not occur. Consideration is given to the design of foundations with a crawl space or basement, with their problems of sidegrip and horizontal frost pressure. Frost protection for unheated buildings is described, usually involving the use of insulation and drainage layers below the foundation with ground insulation nearby to retain soil heat. Designs with open foundations are described, as well as foundations for retaining walls and bridges. Frost protection required during winter construction is detailed.

M 92-02
REVIEW OF THE PROCESSES THAT CONTROL SNOW FRICTION.
Colbeck, S.C., Apr. 1992, 40p., ADA-252 362, Refs. p.37-40.
46-4366
SNOW PHYSICS, PLASTICS SNOW FRICTION, POLYMERS, SLIDING, MELTWATER, SKIS, LUBRICANTS, ANALYSIS (MATHEMATICS), TEMPERATURE EFFECTS, SURFACE ROUGHNESS.
There is a long history of interest in snow friction, but it is necessary to speculate about the details of the processes. Roughness elements and contact areas must be characterized before the basic processes can be well understood. These parameters change with movement over snow and, in fresh snow, probably change along the length of the slider. Friction results from a mixture of processes: dry, lubricated, and possibly capillary. Dry rubbing occurs at low speeds, loads, and/or temperatures and is characterized by solid-to-solid interactions requiring solid deformation. With small quantities of meltwater present, the contact area increases and there may be capillary attachments. Static charging probably occurs and may attract dirt that, even in the size range of micrometers, could complicate the processes. Slider thermal conductivity and even color are very important. Heat is generated by friction and solar radiation absorption but some is conducted away by the slider and ice particles. The remaining heat is available to generate meltwater, which acts as a lubricant. Polyethylene bases offer many advantages including low ice adhesion, high hydrophobicity, high hardness and elasticity, good machinability, and good absorption of waxes. While sliders must be designed for use over a narrow range of snow and weather conditions, polyethylene bases can be structured and waxed to broaden that range. The important processes operate not at the air temperature, but at the ski base temperature, which is highly dependent on such things as snow surface temperature, load, and speed.

TECHNICAL DIGESTS

TD 90-01
LUBRICANTS AT LOW TEMPERATURES.
Diemand, D., Dec. 1990, 24p., ADA-234 536, 21 refs.
45-2487
LUBRICANTS, LOW TEMPERATURE TESTS, COLD WEATHER PERFORMANCE, TEMPERATURE EFFECTS.

TD 91-01
FRAZIL ICE BLOCKAGE OF INTAKE TRASH RACKS.
Daly, S.F., Mar. 1991, 12p., ADA-235 724, 14 refs.
45-2921
FRAZIL ICE, WATER INTAKES, ICE CONTROL.

TD 91-02
AUTOMOTIVE FUELS AT LOW TEMPERATURES.
Diemand, D., Mar. 1991, 25p., ADA-236 040, 21 refs.
45-2920
FUELS, MOTOR VEHICLES, COLD WEATHER PERFORMANCE.

TD 91-03
AUTOMOTIVE AND CONSTRUCTION EQUIPMENT FOR ARCTIC USE; HEATING AND COLD STARTING.
Diemand, D., Apr. 1991, 28p., ADA-236 039, 17 refs.
45-2919
MOTOR VEHICLES, ENGINES, HEATING, ENGINE STARTERS, COLD WEATHER PERFORMANCE.

TD 91-04
AUTOMOTIVE BATTERIES AT LOW TEMPERATURES.
Diemand, D., May 1991, 23p., ADA-239 115, 12 refs.
46-45
ELECTRIC EQUIPMENT, ELECTRIC POWER, COLD WEATHER PERFORMANCE, LOW TEMPERATURE RESEARCH, DESIGN CRITERIA, WINTER MAINTENANCE, MOTOR VEHICLES.
Twelve-volt lead-acid batteries are almost universally used for electrical storage in automotive and construction vehicles in all areas. However, their performance depends strongly on temperature. This digest deals primarily with the performance of this type of battery at low operating temperatures.

TD 91-05
AUTOMOTIVE AND CONSTRUCTION EQUIPMENT FOR ARCTIC USE; MATERIALS AND PROBLEMS.
Diemand, D., Nov. 1991, 23p., ADA-244 835, 16 refs.
46-2568
CONSTRUCTION EQUIPMENT, COLD WEATHER OPERATION, COLD WEATHER PERFORMANCE, COLD WEATHER CONSTRUCTION, MOTOR VEHICLES, TEMPERATURE EFFECTS, METALS, PLASTICS, BRITTLENESS, CRACKING (FRACTURING).
The objective of this digest is to provide a discussion of the general types of problems that will be encountered in automotive and construction equipment when used in the extreme cold and to provide guidelines for overcoming them. The properties and problems of metals are discussed first, followed by a discussion of plastics and elastomers.

MISCELLANEOUS PUBLICATIONS

MP 2767
SURFACE ENERGY BALANCE AND SURFACE TEMPERATURE IN COLD REGIONS.
Lunardini, V.J., et al, International Conference on Development and Commercial Utilization of Technologies in Polar Regions, Copenhagen, Denmark, Aug. 14-16, 1990. Proceedings. Polartech '90, Hörsholm, Denmark, Danish Hydraulic Institute, 1990, p.101-110, 23 refs.
Ibrahim, H.
45-124
HEAT BALANCE, SURFACE TEMPERATURE, SOIL AIR INTERFACE, FROST PENETRATION, THAW DEPTH, MATHEMATICAL MODELS, SEASONAL FREEZE THAW, SOIL FREEZING, GROUND THAWING.
The surface energy balance controls the surface temperature and hence the amount of energy exchanged between the cryosphere and the atmosphere. The temperature of the atmosphere is only one of the components of this energy balance and cannot, of itself, accurately describe the interaction between the atmosphere and soil masses in cold regions. A number of sites are available for which the seasonal values of the ground surface temperature and daily values of radiation and atmospheric conditions have been measured. The sites chosen for this study are particularly simple since the surfaces are paved and thus evapotranspiration need not be considered. Daily weather data were used to calculate radiation and sensible heat fluxes with standard equations. The calculated values agreed reasonably well with daily data for the sites and somewhat better for seasonal values. A simple phase change model for the ground mass allowed the seasonal (freeze or thaw) values of the ground surface temperature to be predicted; these predictions showed excellent agreement with measured quantities.

MP 2768
SEVERE FREEZING PERIODS AND THE FORMATION OF ICE JAMS AT SALMON, IDAHO.
Bilello, M.A., International Conference on Development and Commercial Utilization of Technologies in Polar Regions, Copenhagen, Denmark, Aug. 14-16, 1990. Proceedings. Polartech '90, Hörsholm, Denmark, Danish Hydraulic Institute, 1990, p.235-244, 3 refs.
45-137
ICE JAMS, FLOODS, METEOROLOGICAL FACTORS, RIVER ICE, AIR TEMPERATURE, DEGREE DAYS, UNITED STATES—IDAHO—SALMON RIVER.

MP 2769
ELEMENTAL COMPOSITION, MORPHOLOGY AND CONCENTRATION OF PARTICLES IN FIRN AND ICE CORES FROM DYE-3, GREENLAND.
Kumai, M., et al, *Bulletin of glacier research,* May 1990, No.8, p.1-18, 26 refs.
Langway, C.C., Jr.
45-194
ICE CORES, FIRN, ICE COMPOSITION, IMPURITIES, SCANNING ELECTRON MICROSCOPY, X RAY ANALYSIS, GREENLAND.
A variety of particles extracted from firn and ice core samples from DYE-3, Greenland, was investigated to characterize the type, nature and concentrations of material. A scanning electron microscope (SEM) and an energy dispersive X-ray (EDX) analyzer were employed to analyze particles in firn samples from three annual layers (1981-1983 A.D.) and ice core samples from depth of 833.412 m corresponding to 45 B.C. The particles were extracted by filtering the meltwater of each firn or ice sample with a nuclepore membrane filter having 0.4 micron pore diameter. In the firn samples (1981-1983 A.D.) relatively high concentrations of clay and silt particles were found, and low concentrations of quartz, pine pollen, spores and spherule particles. Some spherules were identified as coal fly ash by SEM and EDX analysis. In the deep ice core samples from 45 B.C., relatively high concentrations of clay and silt particles were found, and some pine pollen, spores and spherules. Some spherules are possibly of extraterrestrial origin. The mean concentration of particles in firn samples from 1981-1983 was 6.4 times higher than that of ice cores from 611 A.D., 45 B.C. and 730 B.C. The mean concentration of spherules in the firn was 27.3 times higher than that of the ice cores. The increase of spherules in the recent firn is mostly a result of deposition of coal fly ash spherules from modern industrial sources.

MP 2770
INTERPRETATION OF THE STRESS HISTORIES FROM SHOCK IMPACT TESTS ON SNOW USING EMBEDDED STRESS GAUGES.
Johnson, J.B., et al, Shock Compression of Condensed Matter-1989. Edited by S.C. Schmidt, J.N. Johnson and L.W. Davison, Elsevier Science Publishers, 1990, p.117-120, 6 refs.
Brown, J.A., Gaffney, E.S.
45-400
SNOW STRENGTH, IMPACT TESTS, SHOCK WAVES, MODELS, SNOW LOADS, STRESSES.

MP 2771
FROZEN GROUND EFFECTS ON INFILTRATION AND RUNOFF.
Kane, D.L., et al, Cold regions hydrology and hydraulics. Edited by W.L. Ryan and R.D. Crissman, New York, American Society of Civil Engineers, 1990, p.259-300, Refs. p.293-300.
Chacho, E.F., Jr.
45-410
FROZEN GROUND MECHANICS, UNFROZEN WATER CONTENT, SOIL WATER MIGRATION, THERMAL REGIME, SEEPAGE, GROUND WATER, SNOWMELT, FROZEN GROUND PHYSICS, HYDROLOGY, HYDROLOGIC CYCLE.
Frozen soils in cold regions play a very dominant role in hydrologic processes. Both seasonal frost and permafrost can significantly reduce both infiltration into and migration through soils; at the same time, the amount of water that can be stored in the soil is severely reduced when permafrost exists. The behavior of frozen soils is most critical in determining the amount of groundwater recharged and the amount of runoff generated. Groundwater recharge from snowmelt in cold regions can be very important when the snowpack represents a large percentage of the annual precipitation. The moisture distribution within the frozen soil is the most significant factor in determining the hydrologic response of the soil. High moisture contents within the frozen soil can reduce the hydraulic conductivity of the soil by several orders of magnitude; such reductions will drastically influence both the volume and peak values of runoff. Most existing hydrologic models do not take into consideration the changes that occur in the hydraulic properties of seasonally frozen soils. Therefore, these models cannot be calibrated to accurately predict runoff when there are large variances in hydrologic properties.

MP 2772
VARIATIONS IN MECHANICAL PROPERTIES WITHIN A MULTI-YEAR ICE FLOE.
Tucker, W.B., et al, Oceans '89 Conference, Seattle, Washington, Sep. 18-21, 1989. Proceedings, Volume 4, Institute of Electrical and Electronic Engineers, 1989, p.1287-1291, 15 refs.
Richter-Menge, J.A., Gow, A.J.
45-446
SEA ICE, ICE COMPOSITION, MECHANICAL PROPERTIES, FLEXURAL STRENGTH, ICE FLOES, POROSITY, SALINITY.

MP 2773
MONITORING RIVER ICE WITH LANDSAT IMAGES.
Gatto, L.W., *Remote sensing of environment,* 1990, Vol.32, p.1-16, 42 refs.
45-484
RIVER ICE, SPACEBORNE PHOTOGRAPHY, PHOTOINTERPRETATION, LANDSAT, ICE NAVIGATION, ICE FORECASTING, RESOLUTION, CLASSIFICATIONS.
In the northern United States, ice can delay or stop river navigation in the winter and cause unexpected problems and emergencies. As part of a program to develop a river ice forecasting model, photointerpretation techniques were used to map the areal distributions of four classes of river ice along the navigable reaches of the Allegheny, Monongahela, and Ohio Rivers and the Illinois Waterway each winter from 1972 to 1985 from Landsat images. The four classes, 1) ice-free, 2) partial gray ice, 3) complete gray ice, and 4) white ice, were usually readily apparent on the images due to differences in gray tones produced by the various ice types and conditions that make up the different classes. Landsat-derived ice observations compared favorably with available ground and aerial observations 64-80% of the time. For many rivers in cold regions, Landsat images may be the only source of data on river ice.

MP 2774
FORECASTING SUPERSTRUCTURE ICING FOR NAVY COMBATANTS.
Ryerson, C.C., U.S. Navy Symposium on Arctic/Cold Weather Operations of Surface Ships, Nov. 29-Dec. 1, 1989. Proceedings. Volume 1, Washington, D.C., Dept of the Navy, [1989], p.287-296, 18 refs.
45-542
SHIP ICING, SUPERSTRUCTURES, ICE FORECASTING, ICE MODELS, ICE ACCRETION, RESEARCH PROJECTS.
A quasi-deterministic model of superstructure icing is being developed through CRREL at the University of Alberta for forecasting ice growth and load distribution on a Spruance-class cruiser. The model will compute spray cloud liquid water content and trajectory with ship heading and speed, sea state and weather, and will evaluate the spray droplet energy budget. Spray salinity, brine drainage, ship attitude, and superstructure shape are evaluated for their effects upon ice growth and distribution. Spray flux cannot be numerically evaluated with the current understanding of hydrodynamic processes, and thus the model relies upon empirically derived algorithms for water delivery on a Navy ship. This paper describes the model structure, progress of the model development, and its potential utility.

MP 2775
EFFECTIVENESS OF DEICING CHEMICALS IN REDUCING ICE ADHESION TO NONSKID SURFACES.
Lever, J.H., et al, U.S. Navy Symposium on Arctic/-Cold Weather Operations of Surface Ships, Nov. 29-Dec. 1, 1989. Proceedings. Volume 1, Washington, D.C., Dept of the Navy, [1989], p.297-307, 12 refs.
Rand, J.H., Gooch, G.E.
45-543
ICE ADHESION, ICE REMOVAL, SKID RESISTANCE, ICE ACCRETION, SHIP ICING, AIRCRAFT LANDING AREAS, IMPACT TESTS.
Through a series of laboratory tests, the effectiveness of 8 different deicing chemicals in reducing ice adhesion to the rough, nonskid surfaces used on aircraft carrier flight decks were examined. The test samples consisted of 18 in. x 18 in. coated steel plates, which were first sprayed with a light coating of liquid deicer which then accreted a uniform layer of freshwater glaze ice. To determine the shear adhesion strength, the iced samples were dropped onto a stiff spring, and the acceleration required to shed the ice was then measured. It was found that a relatively small amount of deicer, applied in advance of ice accretion, is extremely effective in reducing ice adhesion to nonskid surfaces. Such results suggest that advance application of deicing chemicals would significantly assist ice removal from carrier flight decks.

MP 2776
CONCURRENT REMOTE SENSING OF ARCTIC SEA ICE FROM SUBMARINE AND AIRCRAFT.
Wadhams, P., et al, Studies of sea ice thickness and characteristics from an arctic submarine cruise. Phase 3. Final report, Cambridge, England, SAIC Polar Oceans Associates, Feb. 20, 1990, 20p., ADA-219 391, Included as Appendix 1. 6 refs. For another version see 44-3376.
Comiso, J.C., Cowan, A.M., Crawford, J.P., Jackson, G., Krabill, W.B., Kutz, R., Sear, C.B., Swift, R.N., Tucker, W.B., Davis, N.
45-563
SEA ICE, ICE BOTTOM SURFACE, ICE COVER THICKNESS, ICE SURFACE, REMOTE SENSING, SUBGLACIAL OBSERVATIONS, AIRBORNE RADAR.

MP 2777
TOP/BOTTOM MULTISENSOR REMOTE SENSING OF ARCTIC SEA ICE.
Comiso, J.C., et al, Studies of sea ice thickness and characteristics from an arctic submarine cruise. Phase 3. Final report, Cambridge, England, SAIC Polar Oceans Associates, Feb. 20, 1990, 56p., ADA-219 391, Included as Appendix 2. 27 refs.
Wadhams, P., Krabill, W.B., Swift, R.N., Crawford, J.P., Tucker, W.B.
45-564
SEA ICE, ICE BOTTOM SURFACE, ICE COVER THICKNESS, ICE SURFACE, REMOTE SENSING, SUBGLACIAL OBSERVATIONS, AIRBORNE RADAR.

MP 2778
GEOPHYSICS IN THE STUDY OF PERMAFROST.
Scott, W.J., et al, Geotechnical and environmental geophysics. Volume 1. Review and tutorial. Edited by S.H. Ward, Tulsa, Society of Exploration Geophysicists, 1990, p.355-384, Refs. p.376-384. For earlier version see 34-1682.
Sellmann, P.V., Hunter, J.A.
45-668
PERMAFROST STRUCTURE, PERMAFROST DISTRIBUTION, PERMAFROST THERMAL PROPERTIES, PERMAFROST PHYSICS, PERMAFROST DEPTH, GEOPHYSICAL SURVEYS, EXPLORATION, GEOCRYOLOGY, ACOUSTIC MEASUREMENT, SEISMIC SURVEYS, RADAR ECHOES.

MP 2779
INFLUENCE OF SHAPE ON ICEBERG WAVE-INDUCED VELOCITY STATISTICS.
Lever, J.H., et al, *Journal of offshore mechanics and arctic engineering,* Aug. 1990, Vol.112, p.263-269, 12 refs. For another version see 42-2093.
Sen, D., Attwood, D.
45-716
ICEBERGS, DRIFT, VELOCITY MEASUREMENT, PHYSICAL PROPERTIES, WATER WAVES, IMPACT, SIMULATION, OFFSHORE STRUCTURES, MECHANICAL TESTS.

MP 2780
APPROXIMATE THERMODYNAMICS OF THE LIQUID-LIKE LAYER ON AN ICE SPHERE BASED ON AN INTERPRETATION OF THE WETTING PARAMETER.
Takagi, S., *Journal of colloid and interface science,* July 1990, 137(2), p.446-455, 17 refs.
45-795
ICE SURFACE, WETTABILITY, ICE WATER INTERFACE, ICE PHYSICS, WATER FILMS, THERMODYNAMIC PROPERTIES, ANALYSIS (MATHEMATICS), ICE VAPOR INTERFACE.
The approximate thermodynamics of a liquid-like layer, which was originally developed for a planar ice surface based on an interpretation of the wetting parameter, is extended to a spherical ice surface to help discover the effects of the liquid-like layer on the properties of an ice surface.

MP 2781
PATH-AVERAGED TURBULENT HEAT FLUXES FROM SCINTILLATION MEASUREMENTS AT TWO WAVELENGTHS.
Andreas, E.L., *Society of Photo-Optical Instrumentation Engineers. Proceedings,* Apr. 1990, Vol.1312, p.93-105, 26 refs.
45-804
SCINTILLATION, HEAT FLUX, TURBULENT FLOW, ANALYSIS (MATHEMATICS).
Measuring the scintillation of two electromagnetic waves that have propagated over a horizontal path near the earth's surface is tantamount to measuring the turbulent surface fluxes of sensible and latent heat, if the wavelengths were chosen correctly. The author calls this the two-wavelength method, and shows how to choose the two wavelengths and how to find the heat fluxes from a scintillation variable, the refractive index structure parameter. We optimize the two-wavelength method by pairing a short wavelength —one in the visible or infrared regions—with a long wavelength —one in the millimeter or radio regions. With such a two-wavelength combination, sensible heat and latent heat will, typically, have uncertainties of 10-20% when the Bowen ratio, Bo = sensible heat divided by latent heat, obeys $-2.5 < Bo < -0.015$ or $0.03 < Bo < 5$.

MP 2782
SEA-ICE THICKNESS MEASUREMENT USING A SMALL AIRBORNE ELECTROMAGNETIC SOUNDING SYSTEM.
Kovacs, A., et al, *Geophysics,* Oct. 1990, 55(10), p.1327-1337, 21 refs.
Holladay, J.S.
45-837
SEA ICE, ICE ACOUSTICS, ELECTROMAGNETIC PROSPECTING, ICE COVER THICKNESS, ACOUSTIC MEASUREMENT, AIRBORNE EQUIPMENT, DRIFT.
The evaluation of a small electromagnetic induction sounding system for use in airborne measurement of sea-ice thickness is discussed, as are the results from arctic field testing. Also outlined are the system noise and drift problems encountered during arctic field evaluation, problems which adversely affected the quality of the sounding data. The sea-ice sounding results indicate that for ice floes with moderate relief it should be possible to determine thickness to within 5 percent, but that because of sounding footprint size and current model algorithm constraints, steep-sided pressure ridge keels cannot be well defined. The findings also indicate that with further system improvement the day of routine sea-ice thickness profiling from an airborne platform is close at hand.

MP 2783
INFLUENCE OF ENVIRONMENTAL CONDITIONS ON ACOUSTICAL PROPERTIES OF SEA ICE.
Jezek, K.C., et al, *Journal of the Acoustical Society of America,* Oct. 1990, 88(4), p.1903-1912, 13 refs.
Stanton, T.K., Gow, A.J., Lange, M.A.
45-838
SEA ICE, ICE ACOUSTICS, ICE THICKNESS.
Sonar echo amplitude data have been collected at carrier frequencies of 188 and 120 kHz from the underside of different sea ice types. Histograms of normal incidence echo amplitudes were formed from over 90 samples of each ice type. Experiments were conducted on saline ice grown in an outdoor pond under relatively controlled conditions at the USA Cold Regions Research and Engineering Laboratory (CRREL), and on the sea ice cover in the Fram Strait. Analysis shows marked variations (about a factor of 5) in the magnitude of the coherent reflection coefficients as congelation ice at the bottom of an ice sheet evolves from a growing dendritic interface to an ablating, thermally altered interface. Larger differences (about a factor of 10) are observed between growing congelation ice and slush ice, used to simulate frazil. These results indicate that important variations in acoustic regime exist in areas where different ice types are intermingled.

MP 2784
LIQUID CHROMATOGRAPHIC METHOD FOR DETERMINATION OF EXPLOSIVES RESIDUES IN SOIL: COLLABORATIVE STUDY.
Bauer, C.F., et al, *Journal of the Association of Official Analytical Chemists,* 1990, 73(4), p.541-552, 13 refs.
Koza, S.M., Jenkins, T.F.
45-839
EXPLOSIVES, SOIL POLLUTION, STATISTICAL ANALYSIS.
A collaborative study of a sonic extraction/liquid chromatographic method for determining nitroaromatic and nitramine explosives in soil was conducted at 8 participating laboratories. Analytes HMX, RDX, TNB, DNB, tetryl, TNT, and 2,4-DNT were measured in duplicate for 4 field-contaminated soils and 4 spiked standard-matrix soils. Concentrations ranged from detection limits of about 1 microgram/g to nearly 1000 micrograms/g. Results were evaluated with and without data identified as outliers, which were often caused by electronic integrator miscalculation of chromatographic peak response. When outliers are excluded, method repeatability (within-laboratory relative standard deviation) for all analytes except tetryl is less than 5% for spiked soils and less than 18% for field-contaminated soils. Relative standard deviation generally decreases as analyte concentration increases. Reproducibility (between-laboratory relative standard deviation), except for tetryl and DNT, is less than 7% for spiked soils and 26% for field-contaminated soils. Thus, collaborators have nearly equivalent performance on spiked samples. For field-contaminated soils, some additional imprecision seems to result from the variability of extraction recoveries. Analyte recoveries from spiked soils are 95-97% for HMX, RDX, TNT, and DNT (similar to recoveries from aqueous samples); 92-93% for DNB and TNB; and 70% for tetryl. Poor results for tetryl (due to thermal degradation) are correctable if sonic bath temperatures are maintained near ambient. The method has been approved interim official first action by AOAC.

MP 2785
REFLECTION CRACKING STUDIES AT THULE AIR BASE, GREENLAND USING AC 2.5 AND FABRICS.
Eaton, R.A., et al, *Association of Asphalt Paving Technologists Technical Sessions. Proceedings,* Feb. 1980, Vol.49, p.381-396, 7 refs.
Godfrey, R.N.
45-995
RUNWAYS, CRACKING (FRACTURING), PAVEMENTS, COUNTERMEASURES, COLD WEATHER PERFORMANCE, GEOTEXTILES, BITUMINOUS CONCRETES, INTERFACES, GREENLAND—THULE AIR BASE.

MP 2786
TWO-DIMENSIONAL NUMERICAL MODELLING OF LARGE MOTIONS OF FLOATING BODIES IN WAVES.
Sen, D., et al, International Conference on Numerical Ship Hydrodynamics, 5th, Hiroshima, Japan, Sep. 25-29, 1989. Pt. I, 1989, p.257-277, 42 refs.
Pawlowski, J.S., Lever, J.H., Hinchey, M.J.
45-967
SHIPS, HYDRODYNAMICS, WAVE PROPAGATION, WATER WAVES, COMPUTERIZED SIMULATION, VISCOSITY, FLOATING STRUCTURES.
A numerical method is described which simulates in the time domain the propagation of steep two dimensional periodic waves and the large motions induced by the waves on free floating bodies. The method allows for mild transient phenomena. In addition to several numerical results, computations of the sway forces and the roll and heave motions induced by steep periodic waves on a floating body restrained in the sway mode are presented and compared with the results of specially conducted model tests.

MP 2787
DETERMINATION OF THE FLUID-ELASTIC STABILITY THRESHOLD IN THE PRESENCE OF TURBULENCE: A THEORETICAL STUDY.
Lever, J.H., et al, *Journal of pressure vessel technology,* Nov. 1989, Vol.111, p.407-419, 27 refs.
Rzentkowski, G.
45-968
FLUID FLOW, TURBULENT FLOW, PIPES (TUBES), STABILITY, FATIGUE (MATERIALS), VIBRATION, HEAT TRANSFER, ELASTIC PROPERTIES.
A model has been developed to examine the effect of the superposition of turbulent buffeting and fluid-elastic excitation on the response of a single flexible tube in an array exposed to cross-flow. Turbulence is shown to have a significant effect on the determination of the stability threshold for the array. Different stability criteria are compared, and an attempt is made to provide some guidance in the interpretation of response curves from actual tests.

MP 2788
MODEL STUDY OF THE WAVE-DRIVEN IMPACT OF BERGY BITS WITH A SEMI-SUBMERSIBLE PLATFORM.
Lever, J.H., et al, *Journal of offshore mechanics and arctic engineering,* Nov. 1990, Vol.112, p.313-322, 21 refs. For another version see 43-2650.
Colbourne, B., Mak, L.M.
45-998
ICEBERGS, ICE LOADS, OFFSHORE STRUCTURES, IMPACT TESTS, OCEAN WAVES, HYDRAULIC STRUCTURES, ANALYSIS (MATHEMATICS).
This paper describes model bergy bit/semi-submersible impact tests conducted in the 58 m wave tank at Memorial University. The objective of the tests was to develop a method to accumulate statistics on the locations and velocities of wave-driven iceberg/structure impacts. A single irregular sea state was used and 30 trials were conducted in each test series to accumulate the desired statistics. During each run, a camera system tracked the motions of both the bergy bit and the semi-submersible. This data and the geometry of both bodies was transferred to a CAD (computer-aided design) facility, which then recreated each test by redrawing the positions of the two bodies at each time step. In this manner, the impact locations and times without the obstruction of the water surface were determined, and the desired impact velocities and kinetic energies were computed. This paper describes the test and analysis techniques, and presents results for one test series. It also describes a new method to estimate impact kinetic energies using only open-water velocity data.

MP 2789
EVOLUTION OF SEA ICE OPTICAL PROPERTIES DURING FALL FREEZE-UP.
Perovich, D.K., *Society of Photo-Optical Instrumentation Engineers. Proceedings,* 1990, Vol.1302, Ocean optics 10, p.520-531, 16 refs.
45-850
SEA ICE, ICE OPTICS, SEA WATER FREEZING, ALBEDO, FREEZEUP, SNOW COVER EFFECT.
During the seasonal transition from summer to winter conditions a profound transformation occurs in a sea ice cover. As air temperatures drop, the ice cools causing a reduction in the brine volume, melt ponds freeze, new ice forms in areas of open water, and the surface becomes snow-covered. There is a corresponding evolution in the optical properties of the ice cover with albedos increasing and transmittances decreasing. As part of the drift phase of the Coordinated Eastern Arctic Experiment (CEAREX), spectral albedos and reflectances in the visible and near-infrared (400-1100 nm) were measured during fall freeze-up. Observed albedos are presented for first-year ice, multiyear ice, and new-ice cases. In general, albedos increased as freeze-up progressed, with the increase being most pronounced at shorter wavelengths. There was a sharp increase in albedo associated with the surface becoming snow-covered. The greatest temporal changes occurred in a freezing lead where albedos increased from 0.1 for open water to 0.9 for snow-covered young ice in only a few days. The evolution of the transmitted radiation field under the ice was estimated using a simple two-stream radiative transfer model in conjunction with observations of ice morphology and thickness. Light transmission decreased dramatically due to ice cooling, snowfall, and declining incident solar irradiances.

MP 2790
SOLAR HEATING OF A STRATIFIED OCEAN IN THE PRESENCE OF A STATIC ICE COVER.
Perovich, D.K., et al, *Journal of geophysical research,* Oct. 15, 1990, 95(C10), p.18,233-18,245, 32 refs.
Maykut, G.A.
45-1020
SOLAR RADIATION, SEA ICE, SEA WATER, RADIATION ABSORPTION, MELTWATER, WATER TEMPERATURE, ICE WATER INTERFACE, ICE COVER EFFECT, CANADA—NORTHWEST TERRITORIES—MOULD BAY.

MP 2791
ANATOMY OF A FREEZING LEAD.
Gow, A.J., et al, *Journal of geophysical research,* Oct. 15, 1990, 95(C10), p.18,221-18,232, 19 refs.
Meese, D.A., Perovich, D.K., Tucker, W.B.
45-1021
SEA WATER FREEZING, ICE GROWTH, FREEZEUP, ICE STRUCTURE, ICE COMPOSITION, ICE SAMPLING, ICE COVER THICKNESS, ICE AIR INTERFACE, HEAT LOSS.

MP 2792
FREEZING OF WATER AND WASTEWATER SLUDGES.
Vesilind, P.A., et al, *Journal of environmental engineering,* Sep.-Oct. 1990, 116(5), p.854-862, 20 refs.
Martel, C.J.
45-1086
SLUDGES, FREEZING, WASTE TREATMENT, FREEZE THAW CYCLES, FREEZING RATE, ICE CRYSTAL GROWTH, HYGROSCOPIC WATER, COLLOIDS.

MP 2793
METHOD FOR PREDICTING FREEZING IN FORCED FLOW.
Albert, M.R., et al, Fundamentals of phase change: freezing, melting, and sublimation. Edited by Y. Bayazitoglu and P.G. Kroeger, New York, American Society of Mechanical Engineers, 1990, p.9-14, 15 refs.
Olfe, D.B.
45-1163
ICE GROWTH, LAMINAR FLOW, FREEZING, ICE PHYSICS, ICE FORECASTING, PHASE TRANSFORMATIONS, ICE FORMATION, MATHEMATICAL MODELS.
A numerical method for calculating freezing in forced laminar flow with the possibility of recirculation in the flow is presented. The method is applied to problems involving smooth and stepped ice interfaces for flow between parallel plates.

MP 2794
INTERNATIONAL CLASSIFICATION FOR SEASONAL SNOW ON THE GROUND.
Colbeck, S.C., et al, International Association of Scientific Hydrology. International Commission on Snow and Ice. Working Group on Snow Classification. International Association of Scientific Hydrology, [1990], 23p.
Akitaya, E., Armstrong, R., Gubler, H., Lafeuille, J., Lied, K., McClung, D.M., Morris, E.M.
45-1174
SNOW COVER, SNOW MORPHOLOGY, PHYSICAL PROPERTIES, CLASSIFICATIONS, SNOW CRYSTAL STRUCTURE, SNOW COVER STRENGTH, MEASUREMENT.

MP 2795
ATMOSPHERIC ICING WITH ELEVATION ON NEW ENGLAND MOUNTAINS.
Ryerson, C.C., International Conference on Atmospheric Icing of Structures, 4th, Paris, Sep. 5-7, 1988, 1988, p.89-93, 11 refs.
45-1318
ICING, ICE ACCRETION, ALTITUDE, MOUNTAINS, ICING RATE, WIND FACTORS.
Variations in atmospheric icing conditions with elevation on three New England mountains were analyzed statistically. Icing was monitored along a west-facing vertical transect of 1100-m Madonna Peak in the Green Mountains, and at the summits of New Hampshire's 1917-m Mount Washington and Vermont's 1339-m Mount Mansfield. Icing rarely occurs below 800 m, and increases approximately exponentially to the summit elevation of Mount Washington. Ice accretion along slopes near the ground surface correlates with relief exposure, with even slight promontories accumulating more ice than hollows. At the summits, icing occurs about three times as often on Mount Washington as on Mount Mansfield, and mean monthly icing rates are about 50 times greater on Mount Washington.

MP 2796
DENSITY OF NATURAL ICE ACCRETIONS.
Jones, K.F., International Conference on Atmospheric Icing of Structures, 4th, Paris, Sep. 5-7, 1988, 1988, p.114-118, 12 refs.
45-1323
ICING, ICE ACCRETION, ICE DENSITY, METEOROLOGICAL FACTORS, ANALYSIS (MATHEMATICS), ICE FORECASTING.
The particular meteorological conditions under which atmospheric icing occurs determine the density of the accreted ice. Density information is required to calculate the accreted ice load on an object. A density formula developed by Macklin (1962) from artificially iced samples is often used to calculate rime ice density as a function of R (effective droplet diameter multiplied by droplet impact speed divided by icing surface temperature). In this study icing data collected in natural conditions at the summit of Mt. Washington in New Hampshire was used to test Macklin's relationship. The Mt. Washington Observatory has been making icing measurements using rotating multicylinders since 1969. Meteorological and icing data from these observations were used along with accretion weight and volume data from each of the six cylinders in the multicylinder set to relate ice accretion density to Macklin's R parameter. A least-squares fit for density as a function of R was obtained that indicates a different relationship from that obtained by Macklin. A multiple regression analysis was performed to relate the ice accretion density directly to air temperature, wind speed, cloud liquid water content, cloud median volume droplet diameter, and cylinder diameter.

MP 2797
ARCTIC RESEARCH IN THE UNITED STATES, VOL.4.
U.S. Interagency Arctic Research Policy Committee, Washington, D.C., Fall 1990, 106p.
Brown, J., ed, Bowen, S., ed, Cate, D., ed.
45-1398
INTERNATIONAL COOPERATION, RESEARCH PROJECTS, MEETINGS, EXPEDITIONS, ORGANIZATIONS, POLAR REGIONS.

MP 2802
WINTER SHORT-PULSE RADAR STUDIES ON THE TANANA RIVER, ALASKA.
Delaney, A.J., et al, *Arctic,* Sep. 1990, 43(3), p.244-250, With French summary. 24 refs.
Arcone, S.A., Chacho, E.F., Jr.
45-1421
RIVER ICE, SUBSURFACE INVESTIGATIONS, GROUND WATER, RADAR ECHOES, AERIAL SURVEYS, WATER SUPPLY, SUBGLACIAL OBSERVATIONS, FROST PENETRATION, DIELECTRIC PROPERTIES, WATER TABLE, UNITED STATES—ALASKA.

MP 2803
INTEGRATING RADAR-RAINFALL DATA INTO THE HYDROLOGIC MODELING PROCESS.
Engdahl, T.L., et al, Conference on Operational Precipitation Estimation and Prediction, Anaheim, CA, Feb. 7-8, 1990, Boston, MA, American Meteorological Society, 1990, p.69-73, 14 refs.
McKim, H.L.
45-1430
RAIN, PRECIPITATION (METEOROLOGY), HYDROLOGIC CYCLE, COMPUTERIZED SIMULATION, RADAR.

MP 2804
LIQUID CHROMATOGRAPHIC SEPARATION OF 2,4,6-TRINITROTOLUENE AND ITS PRINCIPAL REDUCTION PRODUCTS.
Walsh, M.E., et al, *Analytica chimica acta,* 1990, Vol.231, p.313-315, 10 refs.
Jenkins, T.F.
45-1431
EXPLOSIVES, MILITARY RESEARCH.
A liquid chromatographic method is described for the baseline separation of 2,4,6-trinitrotoluene (TNT) and its main reduction products. Two analytical columns (LC-18 and LC-CN) are connected in series and eluted isocratically at 1.5 ml/min with water-methanol-tetrahydrofuran (60.5+25+14.5). The capacity factors (k') are 1.4, 1.6, 5.1, 6.4 and 7.0 for 2,6-diamino-4-nitrotoluene, 2,4-diamino-6-nitrotoluene, TNT, 4-amino-2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene, respectively.

MP 2805
MICROCOMPUTER SIMULATION OF PHASE CHANGE HEAT TRANSFER.
Farag, I.H., et al, *International journal of heat and technology,* 1990, 8(1-2), p.43-65, 22 refs.
Buzzell, G.M., Phetteplace, G.
45-1432
HEAT TRANSFER, PHASE TRANSFORMATIONS, COMPUTERIZED SIMULATION, LATENT HEAT, COOLING SYSTEMS, UNDERGROUND PIPELINES, MELTING, FREEZING.
The development of a microcomputer-based finite element program with the ability to simulate phase change (melting and freezing) is outlined. A closed form Galerkin finite element method derived from a delta function formulation of the latent heat discontinuity in the heat capacity versus temperature function is used within phase change elements of the solution domain. Storage reduction data structures are implemented and compared on the basis of overall program execution time. Analytical solutions for melting and freezing are used to verify program accuracy and to explore other simulation parameters such as time step size, mesh density and start-up technique. Several "life like" phase change simulations are compared to the results obtained from other numerical models.

MP 2806
SEASONAL VARIATION OF SOME CONSTITUENTS OF ANTARCTIC TROPOSPHERIC AIR.
Hogan, A.W., et al, *Geophysical research letters,* Dec. 1990, 17(12), p.2365-2368, 22 refs.
Egan, W.G., Samson, J.A., Barnard, S.C., Riley, D.M., Murphey, B.B.
45-1514
METEOROLOGY, AIR MASSES, SEASONAL VARIATIONS, ATMOSPHERIC COMPOSITION, AEROSOLS, CARBON DIOXIDE, WATER VAPOR.
The interior of Antarctica is dominated by the continental Antarctic [cA] air mass, which resides entirely on the antarctic ice, and only receives heat, moisture and particles by exchange with surrounding air masses. The concentrations of carbon dioxide, total aerosol, and soot aerosol do not vary coincidentally in this air mass during antarctic spring. A hypothesis describing the modification of these properties within the cA air mass through exchange with the surrounding air masses and variation of the source strength of marine aerosol in maritime polar air masses is proposed. (Auth.)

MP 2807
O-18 CONCENTRATIONS IN SEA ICE OF THE WEDDELL SEA, ANTARCTICA.
Lange, M.A., et al, *Journal of glaciology,* 1990, 36(124), p.315-323, 34 refs.
Schlosser, P., Ackley, S.F., Wadhams, P., Dieckmann, G.S.
45-1542
SEA ICE DISTRIBUTION, SNOW ICE, OXYGEN ISOTOPES, ICE GROWTH, SNOW COVER EFFECT, ICE COMPOSITION, ICE COVER THICKNESS, ICE FORMATION INDICATORS, ANTARCTICA—WEDDELL SEA.
Data are presented on ice texture, salinity, and *delta*O-18 obtained from identical sections of ice cores during the Winter Weddell Sea Project 1986 on RV *Polarstern* from July through Aug. 1986, in the longitude range between 5W and 7E. No uniquely definable relationship between *delta*O-18 values and ice texture in a particular section is found. However, most of the snow ice as well as some sections of frazil ice are found to have negative *delta* O-18 concentrations, due to varying degrees of admixtures of meteoric ice (snow) and sea-water during formation of snow ice. In contrast to common assumptions, these results seem to indicate that a snow cover contributes positively to sea-ice growth rather than slowing down the overall growth rate. Based on a simple model, the contributions of meteoric ice (mean of 3 +/- 3%) and the combined meteoric ice/sea-water fraction (a minimum of 7 +/- 6%) to the total ice thickness for the majority of the sampled floes are estimated. Although this is only a moderate contribution to the overall mass balance, in the absence of congelation growth it nevertheless enhances ice growth in general. This hypothesis is independently supported by snow- and ice-thickness data which demonstrate that the depression of the snow/ice interface below the water line (i.e. a negative freeboard) and the formation of snow ice is a common occurrence in the Weddell Sea. Therefore, it is hypothesized that the major part of the observed apparent increase in ice thickness between the inbound and outbound tracks of WWSP'86 may not be derived from "regular", thermodynamically driven congelation growth, but rather from the snow-ice component in floes of the Weddell Sea. (Auth. mod.)

MP 2808
THERMAL EXPANSION COEFFICIENTS FOR SEA ICE.
Johnson, J.B., et al, *Journal of glaciology,* 1990, 36(124), p.343-349, 26 refs.
Metzner, R.C.
45-1545
SEA ICE, THERMAL EXPANSION, ICE VOLUME, ANALYSIS (MATHEMATICS), THERMAL ANALYSIS, TEMPERATURE EFFECTS, ICE THERMAL PROPERTIES, SALINITY.
Coefficients of thermal linear expansion were determined for sea ice using a Michelson interferometer. Over a temperature range of -4 to -15 C, the coefficients varied from .000045 to .000054/C for ice with a salinity of 2 ppt, and from .000033 to .000053/C for ice with a salinity of 4 ppt. Initially, warming the sea ice resulted in coefficients that were the same as those for fresh-water ice, within the limits of experimental error. Subsequent sea-ice cooling resulted in coefficients that were initially lower than those for fresh-water ice, but that asymptotically approached the coefficient values for fresh-water ice at colder temperatures. On the second warming and cooling cycle, the coefficients of thermal linear expansion exhibited hysteresis and a decrease in magnitudes. It is also shown that Pettersson's (1883) and Malmgren's (1927) measurements of the thermal volume expansion of sea ice were the result of phase transitions that caused brine expulsion, when air-free sea ice was cooled, and internal porosity increases, when sea ice was warmed. These results indicate that Pettersson's and Malmgren's measurements of the thermal volume expansion of sea ice are in error. Consequently, theoretical descriptions based on their results are incorrect. The results for the initial sea-ice warming cycle do agree with Cox's (1983) analysis.

MP 2809
VAPOR-PRESSURE DEPENDENCE ON TEMPERATURE IN MODELS OF SNOW METAMORPHISM.
Colbeck, S.C., *Journal of glaciology,* 1990, 36(124), p.351-352, 14 refs.
45-1547
METAMORPHISM (SNOW), VAPOR PRESSURE, TEMPERATURE EFFECTS, MATHEMATICAL MODELS, HEAT TRANSFER.

MP 2810
ON THE SYSTEMATIC VARIATION IN SURFACE AEROSOL CONCENTRATION AT THE SOUTH POLE.
Samson, J.A., et al, *Atmospheric research,* 1990, Vol.25, p.385-396, 34 refs.
Barnard, S.C., Obremski, J.S., Riley, D.C., Black, J.J., Hogan, A.W.
45-1429
METEOROLOGY, METEOROLOGICAL INSTRUMENTS, METEOROLOGICAL CHARTS.
Aerosol observations have been made at the Amundsen-Scott Station on a disciplined schedule since Jan. 1974. Analysis of the data shows a repeatable annual cycle in surface aerosol concentration characterized by a twenty-fold increase during the spring months as lower-latitude air is advected onto the Polar Plateau. During the nine-year period 1977-1985, the mean values of the aerosol concentrations for the spring months, as well as for the entire calendar year, decreased. The diminution of surface aerosol at the South Pole appears to be statistically significant.

MP 2811
MOISTURE IN MEMBRANE ROOFS.
Tobiasson, W., *Custom builder,* Aug. 1989, p.31-32, 37-38.
45-1581
ROOFS, MOISTURE, HUMIDITY, VAPOR BARRIERS, CONSTRUCTION MATERIALS.

MP 2812
USING SCINTILLATION AT 2 WAVELENGTHS TO MEASURE PATH-AVERAGED HEAT FLUXES IN FREE CONVECTION.
Andreas, E.L., *Boundary-leyer meteorology,* 1991, Vol.54, p.167-182, 37 refs.
45-1585
SCINTILLATION, BOUNDARY LAYER, HEAT FLUX, CONVECTION, MEASUREMENT, ANALYSIS (MATHEMATICS).
Local free convection scaling is one of the obvious triumphs of boundary-layer similarity theory. In free convection, there is no dynamic velocity scale; the sensible and latent heat fluxes, therefore, scale directly with the temperature and humidity structure parameters. By using scintillation to measure the refractive index structure parameter at two electromagnetic (EM) wavelengths, the temperature and humidity structure parameters can be obtained and thus in effect measure path-averaged values of the sensible and latent heat fluxes. Here the author describes this so-called two-wavelength method for free convection, derives quantitative guidelines for optimizing the method, and evaluates its potential accuracy. The author shows that the two-wavelength method works best when one EM wavelength is in the visible or infrared region and the other is in the millimeter or radio region. When the Bowen ratio is between -5 and -0.1 or between 0.1 and 5, the expected accuracy of the measured fluxes is +/- 10-20%—typical of what is possible with eddy-correlation measurements. With the two-wavelength method, however, the fluxes represent spatial averages.

MP 2813
SEISMIC STUDIES ON THE GRID EASTERN HALF OF THE ROSS ICE SHELF: RIGGS III AND RIGGS IV.
Albert, D.G., et al, *American Geophysical Union. Antarctic research series,* 1990, Vol.42, Ross Ice Shelf: glaciology and geophysics, p.87-108, Refs. p.107-108.
Bentley, C.R.
45-1611
ICE SHELVES, ICE COVER THICKNESS, SEISMIC SURVEYS, BOTTOM TOPOGRAPHY, ICE PHYSICS, SEISMIC REFRACTION, ANTARCTICA—ROSS ICE SHELF.
Seismic P wave refraction experiments at three locations on the Ross Ice Shelf during 1976-1977 (RIGGS III) and 1977-1978 (RIGGS IV) reveal that the velocity increases monotonically in the firn from about 500 m/s at the surface to about 3800 m/s at a depth of 60 m. Maximum P wave velocities measured at 4 locations on the ice shelf show a large range of values primarily indicative of lateral inhomogeneities, but perhaps also resulting from anisotropy. Water depths for 89 additional stations were determined using seismic reflections from the ocean floor, together with ice thicknesses measured by radar and seismic techniques. Systematic differences that appear between ice thicknesses measured by the two techniques on RIGGS IV but not on RIGGS III most likely reflect an unrecognized systematic error in measurement. (Auth. mod.)

MP 2814
QUASI-STEADY PROBLEMS IN FREEZING SOILS: II. EXPERIMENT ON THE STEADY GROWTH OF AN ICE LAYER.
Takeda, K., et al, *Cold regions science and technology,* Nov. 1990, 18(3), p.225-247, 14 refs.
Nakano, Y.
45-1616
SOIL FREEZING, SOIL TESTS, ICE GROWTH, ICE LENSES, THERMAL CONDUCTIVITY, TEMPERATURE GRADIENTS, SOIL WATER MIGRATION.
A series of freezing tests on three kinds of soil were conducted to find the steady growth condition of a segregated ice layer by using a new steady-state method in which the temperature profiles of soil specimens were controlled. It was found that the steady growth condition is determined by the absolute value of the temperature gradient of the unfrozen part of the soil *alpha*u and that of the frozen part of the soil *alpha*f under a given hydraulic condition as follows *alpha*u=S *alpha*f, k1/ko>S>So, *alpha*f<A, where k1 and ko are the thermal conductivity of the frozen and the unfrozen parts, respectively, and So and A constants that are the properties of a given soil. Comparing these experimental results with the results of the mathematical analysis presented in part I, it is found that the model M1 is consistent with the experimental results while the models M2 and M3 contradict them.

MP 2815
REVERSED DIRECT-STRESS TESTING OF ICE: EQUIPMENT AND EXAMPLE RESULTS.
Cole, D.M., et al, *Cold regions science and technology,* Nov. 1990, 18(3), p.295-302, 11 refs.
Gould, L.D.
45-1619
TEST EQUIPMENT, MECHANICAL TESTS, ICE STRENGTH, DESIGN, COMPRESSIVE PROPERTIES.
This paper describes in detail a recently developed fixture for performing completely reversed (e.g., tension to compression) uniaxial stress experiments on ice. The device rigidly holds an ice specimen having bonded end caps without loading the specimen or inducing a bending moment. It is self aligning and hydraulically actuated. One of the important and unique features of the system is that it corrects for end-cap misalignment at the end cap rather that at some distance from it. The ideas underlying the design of the system are discussed. The results of a number of experiments are presented to demonstrate the capabilities of the device and to illustrate the types of mechanical property information that can be generated using this experimental technique.

MP 2816
REVERSED DIRECT-STRESS TESTING OF ICE: INITIAL EXPERIMENTAL RESULTS AND ANALYSIS.
Cole, D.M., *Cold regions science and technology,* Nov. 1990, 18(3), p.303-321, 35 refs.
45-1620
ICE STRENGTH, MECHANICAL TESTS, LOADING, DEFORMATION, ICE MICROSTRUCTURE, INTERNAL FRICTION, TEST EQUIPMENT.
This paper focusses on the analysis and discussion of the results of a series of reversed direct-stress experiments performed on freshwater ice. A companion paper (Cole and Gould, this issue) describes the apparatus developed for these experiments. The experimental technique provides a means to subject cylindrical ice specimens to fully reversed (i.e., alternating tension/compression) uniaxial loading, thereby permitting the study of cyclic-loading effects under a uniform stress field. The topics include frequency, temperature and strain-amplitude effects on internal friction; cyclic loading-history effects on tensile strength, grain-size effects on cyclic stress-strain behavior and the Bauschinger effect. The observations are discussed in terms of the mechanisms underlying the behavior, with particular attention to dislocation processes. The observations indicate the operation of the dislocation breakaway process and the Granato-Lucke theory models the associated amplitude-dependent internal friction results extremely well.

MP 2817
RADON MEASUREMENTS AS INDICATORS OF PERMAFROST DISTRIBUTION.
Sellmann, P.V., et al, *Cold regions science and technology,* Nov. 1990, 18(3), p.331-336, 9 refs.
Delaney, A.J.
45-1622
PERMAFROST DISTRIBUTION, GASES, RADIOACTIVITY, MEASUREMENT, SUBSURFACE STRUCTURES, SOIL COMPOSITION, VAPOR DIFFUSION, CORRELATION.
Observations in central Alaska indicate that radon concentrations in surface soils over discontinuous permafrost seem to correspond with frozen-ground distribution. These observations were made to determine if radon measurements might provide a method for obtaining information on permafrost distribution. Radon levels from an area of silty soils varied from 14 to 348 pCi/l and averaged 51 pCi/l where the top of permafrost was within a meter of the ground surface, compared to an average of 190 pCi/l where permafrost was absent.

MP 2818
FROST HEAVE FORCES ON H AND PIPE PILES EMBEDDED IN FAIRBANKS SILT.
Johnson, J.B., et al, *Alaska. Department of Transportation and Public Facilities. Report,* May 1988, FHWA-AK-RD-88-02, 83p., 29 refs.
Buska, J.S.
45-1649
PILES, FROST HEAVE, PERMAFROST BENEATH STRUCTURES, FROZEN GROUND MECHANICS, LOADS (FORCES), ICE ADHESION, SOIL TEMPERATURE, SHEAR STRESS, DESIGN CRITERIA, STRAIN TESTS, ICE SOLID INTERFACE.
The magnitude and variation of forces and shear stresses, caused by frost heaving in Fairbanks silt and the adfreeze effects of a surface ice layer and a gravel layer, were determined using electric strain gauges as a function of depth along the upper 2.75 m of a pipe pile, 30.5 cm I.D. x 0.95 cm wall and an H pile, 25.4 cm web x 85 kg/lineal m, for three consecutive winter seasons (1982-1985). The peak frost heaving forces on the H pile during each winter were 752, 790 and 802 kN. Peak frost heaving forces on the pipe pile of 1118 and 1115 kN were determined only for the second and third winter seasons. Maximum average shear stresses acting on the H pile were 256, 348 and 308 kPa during the three winter seasons. Maximum average shear stresses acting on the pipe pile were 627 and 972 kPa for the second and third winter seasons. Ice collars were placed around the tops of both piles during the first and third winter seasons to measure the adfreeze effects of a surface ice layer. A 0.6 m thick gravel layer replaced the soil around the tops of both piles for the second and third winter seasons to measure the adfreeze effects of a gravel backfill. The gravel layer on the H pile may have contributed about 35% of the peak forces measured. The important mechanisms that determine the magnitude of uplift heave forces are (1) soil heaving as the driving force, and (2) soil temperature, which controls the unfrozen water content, the mechanical properties of the soil and the area of influence of heaving pressures.

MP 2819
MODELLING SEA ICE THERMODYNAMICS AND DYNAMICS IN CLIMATE STUDIES.
Hibler, W.D., III, NATO Advanced Study Institute on Physically-Based Modelling and Simulation of Climate and Climate Change, Part 1. Proceedings, edited by M.E. Schlesinger, Dordrecht, Kluwer Academic Publishers, 1988, p.509-563, 47 refs.
45-1646
SEA ICE, THERMODYNAMIC PROPERTIES, ICE MECHANICS, ICE MODELS, CLIMATE.
The presence of sea ice cover substantially modifies air-sea heat and momentum exchanges in the polar regions, and hence can play a major role in high-latitude climate sensitivity. Because of its mobility, the dynamics and thermodynamics of this ice cover are intrinsically related. The purely thermodynamic properties of sea ice are very dependent on the fact that it is an admixture of brine pockets and fresh water ice. This causes sea ice to have a greater equilibrium thickness than freshwater ice and to have a different seasonal cycle of thickness change. The dynamical features of sea ice are characterized by a highly nonlinear ice interaction that causes the ice pack to strongly resist compression while having a relatively weak resistance to dilation. The strength of the interaction is tied to the amount of thin ice which is created by the opening of leads and is removed by ice growth or pressure ridging. A plastic rheology offers a consistent means of modelling this highly nonlinear ice interaction. Results of several numerical simulations are discussed; these include the response of an antarctic sea ice model to atmospheric warming, and the behavior of a coupled ice-ocean model of the Arctic, Greenland and Norwegian seas. In the case of ice-ocean coupling it is shown that the ocean circulation is essential for realistic simulation of the ice margin in the Greenland and Norwegian seas. (Auth. mod.)

MP 2820
THREE-WAVELENGTH METHOD OF MEASURING PATH-AVERAGED TURBULENT HEAT FLUXES.
Andreas, E.L., *Journal of atmospheric and oceanic technology,* Dec. 1990, 7(6), p.801-814, 36 refs.
45-1665
HEAT FLUX, AIR TEMPERATURE, HUMIDITY, TURBULENT FLOW, LATENT HEAT, ANALYSIS (MATHEMATICS), REFRACTION, OPTICAL PROPERTIES.
Conceptually, electro-optical measurements of the path-averaged refractive index structure parameter should yield measurements of the vertical fluxes of sensible and latent heat. With three independent measurements we can compute the meteorologically relevant temperature, humidity, and temperature-humidity structure parameters. The sensible and latent heat fluxes derive from these and a simultaneous electro-optical measurement of the path-averaged turbulent kinetic energy dissipation rate through inertial-dissipation calculations. A sensitivity analysis shows that at 0.94 micron, 10.6 microns, and 3.33 mm, the three-wavelength method would yield measurements of the temperature structure parameter accurate

to +/- 20% when the Bowen ratio, the sensible heat flux divided by the latent heat flux, is in the range of 0.1 to 10. The measurement of the humidity structure parameter is potentially accurate to +/- 10% but only when the Bowen ratio is 0.01 to 0.5. Outside this range the accuracy is much worse. The measurement accuracy of the temperature-humidity structure parameter is poor. The predicted uncertainty is no better than +/- 40%. This three-wavelength combination, however, can yield the sign of the temperature-humidity structure parameter when the Bowen ratio is 0.015 to 0.5. If instead of the 10.6 micron wavelength we substitute a wavelength of 18.8 microns where laser measurements are more difficult, the Bowen ratio ranges over which we could measure both the humidity structure parameter and the sign of the temperature-humidity structure parameter expand. For the humidity structure parameter, the useful Bowen ratio range is now 0.01 to 1; and for the sign of the temperature-humidity structure parameter, it is roughly 0.02 to 2.

MP 2821
CONVERTING DIGITAL PASSIVE MICROWAVE RADIANCES TO KELVIN UNITS OF BRIGHTNESS TEMPERATURES.
Farmer, L.D., et al, *U.S. Naval Ocean Research and Development Activity. NORDA technical note,* Sep. 1990, No.427, 16p., ADA-228 407, 7 refs.
Eppler, D.T., Lohanick, A.W.
45-932
SEA ICE, BRIGHTNESS, RADIANCE, MICROWAVES, RADIOMETRY.

MP 2822
KRMS GEOSAT-LIMEX '87 DATA PRODUCTS.
Eppler, D.T., et al, *U.S. Naval Ocean Research and Development Activity. NORDA technical note,* July 1988, No.388, 42p., ADA-219 728, 4 refs.
Farmer, L.D.
45-561
SEA ICE DISTRIBUTION, ICE EDGE, REMOTE SENSING, DATA PROCESSING, COMPUTER PROGRAMS, ICE CONDITIONS, CANADA—LABRADOR SEA.

MP 2823
INFLUENCE OF SHORT-TERM CLIMATE FLUCTUATIONS ON PERMAFROST TERRAIN.
Brown, J., et al, *U.S. Department of Energy. Report,* May 1982, Carbon Dioxide Effects Research and Assessment Program. Environmental and Societal Consequences of a Possible CO2-Induced Climate Change Vol.II, Part 3, 33p., DE82 017379, 50 refs.
Andrews, J.T.
45-1931
CLIMATIC CHANGES, PERMAFROST THERMAL PROPERTIES, CARBON DIOXIDE, GEOMORPHOLOGY.

MP 2824
CONTAMINATION OF AQUEOUS SAMPLES WITH FORMATE AND ACETATE FROM AMBIENT AIR.
Hewitt, A.D., et al, *Atmospheric environment,* 1991, 25A(2), p.453-457, 11 refs.
Cragin, J.H.
45-1697
AIR POLLUTION, CHEMICAL ANALYSIS, SOLUTIONS, VAPOR DIFFUSION, WATER CHEMISTRY, MELTWATER, PRECIPITATION (METEOROLOGY).
A sensitive ion chromatographic technique with detection limits of 1.9 and 6.2 micrograms/l has been developed for the determination of formate and acetate ions, respectively, in aqueous solution. Using this technique, uncovered aqueous solutions have been found to absorb the corresponding acids readily from ambient air at rates of approximately 0.02-0.1 nM/sq cm/h. Consequently, to prevent vapor diffusion and subsequent contamination of environmental samples with these organic acids, casual exposure to ambient air, particularly in a laboratory, should be minimized.

MP 2825
ONE-DIMENSIONAL TEMPERATURE MODELING TECHNIQUES: REVIEW AND RECOMMENDATIONS.
Balick, L.K., et al, *U.S. Army Cold Regions Research and Engineering Laboratory. Smart Weapons Operability Enhancement Program Office. Report,* Aug. 1990, SWOE report 90-01, 17p., ADA-231 176, 33 refs.
Hummel, J.R., Smith, J.A., Kimes, D.S.
45-1698
INFRARED PHOTOGRAPHY, COMPUTERIZED SIMULATION, DETECTION, MILITARY RESEARCH, SURFACE TEMPERATURE.
Background surface temperature models were reviewed and evaluated for implementation in the Smart Weapons Operability Enhancement Program. As a result, current capabilities in one-dimensional modeling were determined and specific recommendations for implementation were made. Robust capabilities exist for solid materials, snow, fresh water and simple vegetation layers. Modeling of freshwater ice and sea ice are tractable at this time. Serious deficiencies exist in complex vegetation because of the mix of materials comprising the canopy and their complex geometry. Simulation of most porous solid materials seems inadequate. Recommendations for specific implementation were made in three groups: atmosphere-material energy fluxes, energy fluxes within materials (for several material types), and the initial model framework. The use of the C language version of the Terrain Surface Temperature Model is recommended to serve as an initial model framework for model development. Recommendations for research and development are made for complex vegetation types, mass transport through porous materials, the land/ocean interface, transitional conditions, and quantitative parameter estimation.

MP 2826
WORKSHOP ON TRACTION MECHANICS ON DEFORMABLE TERRAIN, SOUTH LAKE TAHOE, CA, OCT. 9-11, 1989.
Blaisdell, G.L., ed, *U.S. Army Cold Regions Research and Engineering Laboratory,* Jan. 1990, 37p.
45-1968
TRACTION, ALL TERRAIN VEHICLES, SNOW VEHICLES, TRAFFICABILITY, TIRES, MEETINGS.

MP 2827
INITIAL IMPRESSIONS OF A CANDIDATE MOBILE OVER-SNOW TRANSPORT SYSTEM.
Blaisdell, G.L., et al, *U.S. Army Cold Regions Research and Engineering Laboratory,* Apr. 1990, 13p. + appends., 5 refs.
Diemand, D., Young, B.
45-1969
SNOW VEHICLES, ALL TERRAIN VEHICLES, TRACKED VEHICLES, SLEDS, MILITARY TRANSPORTATION.

MP 2828
EFFECT OF FINES IN SAND ON FRICTION ON ICE.
Blaisdell, G.L., et al, *U.S. Army Cold Regions Research and Engineering Laboratory,* Sep. 1990, 16p. + figs.
Borland, S.L.
45-1970
ICE FRICTION, TRACTION, SANDING, FINES, RUNWAYS.

MP 2829
DESIGN OF A MODIFIED CATERPILLAR CHALLENGER TRACTOR FOR ANTARCTIC SERVICE.
Blaisdell, G.L., et al, *U.S. Army Cold Regions Research and Engineering Laboratory,* June 1990, 13p. + figs., 2 refs.
Kurtti, K.
45-1976
SNOW VEHICLES, TRACTORS, TRACKED VEHICLES, TRAVERSES, SLEDS.
The Caterpillar Challenger tractor, modified by an extended track, is recommended as a replacement for the Caterpillar LGP D8 low-ground-pressure tractor in the National Science Foundation's antarctic vehicle fleet. The LGP D8 tractors are now over 30 years old and many of their parts have become unavailable. The Challenger tractor can be used for pulling tracked trailers or sleds with a payload up to 40 tons and at a top speed of 18 mph.

MP 2830
STATUS OF AIRLAND BATTLEFIELD ENVIRONMENT (ALBE) WINTER TACTICAL DECISION AIDS.
Aitken, G.W., et al, *U.S. Army Cold Regions Research and Engineering Laboratory,* Dec. 1990, 14p.
Slota, J.R.
45-1978
COMPUTER PROGRAMS, MILITARY OPERATION, COLD WEATHER OPERATION, VISIBILITY, TRAFFICABILITY, ROUTE SURVEYS, SNOW ROADS.

MP 2831
ANTIFREEZE ADMIXTURES FOR COLD WEATHER CONCRETING.
Korhonen, C.J., et al, *Concrete international,* Mar. 1991, 13(3), p.38-41, 10 refs.
Cortez, E.R.
45-1983
WINTER CONCRETING, CONCRETE ADMIXTURES, ANTIFREEZES.

MP 2832
TOP/BOTTOM MULTISENSOR REMOTE SENSING OF ARCTIC SEA ICE.
Comiso, J.C., et al, *Journal of geophysical research,* Feb. 15, 1991, 96(C2), p.2693-2709, 26 refs. For another version see 45-564.
Wadhams, P., Krabill, W.B., Swift, R.N., Crawford, J.P., Tucker, W.B.
45-2042
SEA ICE, PHYSICAL PROPERTIES, REMOTE SENSING, MEASURING INSTRUMENTS, PERFORMANCE, CORRELATION, RADIOMETRY, ICE BOTTOM SURFACE, RADAR ECHOES, ACOUSTIC MEASUREMENT, LIDAR.
The arctic sea ice cover has been studied using near simultaneous observations by passive and active (synthetic aperture radar, SAR) microwave sensors, upward looking and sidescan sonars, a lidar profilometer, and an infrared sensor. Aircraft and submarine data over 100 km track of central arctic sea ice were registered and analyzed to evaluate the characteristics of the ice cover and the utility of each sensor in ice studies. The results of comparative and correlation analyses are as follows. The probability density functions of ice draft from sonar and elevation from lidar were found to be almost identical when isostasy is taken into account, which suggests that the basic ice thickness distribution can be derived from the surface topography measurements alone. Reasonable correlation was found between SAR backscatter and ice draft. However, surface roughness derived directly from standard deviations in the lidar elevation data was found to be poorly correlated to the SAR backscatter, which indicates that the SAR values are affected more by scattering from the ice than from the snow-covered surface. The active and passive microwave sensors are shown to generally complement each other in sensitivity to different physical properties of the sea ice. Surfaces identified as multiyear ice by the passive system have a large spread in the unaveraged SAR backscatter, indicating limitations when using a one-channel SAR for ice type identification at the highest resolution. Also, ridged ice identified by sonar and SAR data covers a large range of passive microwave emissivity, suggesting considerable variability in the age and salinity of this type of ice. Significant variations (about 0.11) in the minimum emissivity of consolidated multiyear ice are observed in different regions of the Arctic using the high-resolution (30 m) passive microwave data. This suggests that regional variations in texture and scattering characteristics of multiyear ice in the Arctic are present, likely influenced by different histories of formation of the ice in different regions.

MP 2833
POTENTIAL RESPONSE OF ANTARCTIC SEA ICE TO CLIMATIC CHANGE INDUCED BY ATMOSPHERIC CO2 INCREASES.
Ackley, S.F., 1981, 17p. + 3p. refs., Contributed paper to the AAAS report to the Department of Energy on Climatic Impact of Increased CO2 Changes in the Atmosphere. 30 refs.
45-1930
SEA ICE, CARBON DIOXIDE, CLIMATIC CHANGES.
Possible mechanisms are cited by which antarctic sea ice may affect climate. While many mechanisms can be postulated, consideration must be given to the geologic record, relating to correlation between past climatic changes and sea ice action or response, and the state of knowledge about the present day formation and decay of antarctic sea ice, in order to determine, (1) if sea ice will respond to a CO2 induced climate warming and (2) how this sea ice change will affect climate. Some aspects of the antarctic sea ice are unique, readily apparent, and should be considered before such a decision is made. They include: (a) the location of the antarctic sea ice on the southern boundary of the Southern Hemisphere westerly wind system, in mid-latitudes, a major repository of kinetic energy of the general circulation of the atmosphere. Ice transport from the Weddell Sea strongly affects mid-latitude temperature and presumably circulation in the S. Atlantic region at the present time. (b) The "free" boundary of the southern sea ice with the world ocean, qualitatively at least, reflects a more interactive role with global scale processes than does the Arctic. (c) The role of the entire region south of the Polar Front as a "heat exchanger," where heat taken up by the ocean elsewhere is dissipated, affecting the total heat transport by the oceans and the ocean-atmosphere interaction in polar regions. (d) As part of the heat exchange process, the formation of antarctic sea ice leads to thermohaline processes producing Antarctic Bottom Water and thereby affects the meridional heat and salt transport by oceanic waters, as well as the global cycling of sea waters for nutrient and gas exchange. (Auth. mod.)

MP 2834
MICROWAVE AND PHYSICAL PROPERTIES OF SEA ICE IN THE WINTER MARGINAL ICE ZONE.
Tucker, W.B., et al, *Journal of geophysical research,* Mar. 15, 1991, 96(C3), p.4573-4587, 22 refs.
Grenfell, T.C., Onstott, R.G., Perovich, D.K., Gow, A.J., Shuchman, R.A., Sutherland, L.L.
45-2084
SEA ICE, ICE PHYSICS, MICROWAVES, ICE DENSITY, ICE COVER THICKNESS, ICE SALINITY, RADAR, RADIOMETRY, SYNTHETIC APERTURE RADAR.
Surface-based active and passive microwave measurements were made in conjunction with ice property measurements for several distinct ice types in the Fram Strait during Mar. and Apr. 1987. Synthetic aperture radar imagery downlinked from an aircraft was used to select study sites. The surface-based radar scattering cross section and emissivity spectra generally support previously inferred qualitative relationships between ice types, exhibiting expected separation between young, first-year and multiyear ice. Gradient ratios, calculated for both active and passive data, appear to allow clear separation of ice types when used jointly. Surface flooding of multiyear floes, resulting from excessive loading and perhaps wave action, causes both active and passive signatures to resemble those of first-year ice. This effect could possibly cause estimates of ice type percentages in the marginal ice zone to be in error when derived from aircraft- or satellite-borne sensors.

MP 2835
NORTH AMERICAN STANDARD PRACTICES FOR HEAT FLUX AND TEMPERATURE MEASUREMENT IN BUILDING SYSTEMS.
Flanders, S.N., IMEKO (Internationale Messtechnische Konföderation [International Measurement Confederation]) Technical Committee. ITC series, No.9. Heat flux measurement, Budapest, Hungary, OMIKK (Orszagos Muszaki Informacios Ko pont es Konyvtar [National Technical Information Center and Library])—TECHNOINFORM, 1986, p.101-120, 8 refs. Proceedings of the 2nd Workshop.
45-2098
BUILDINGS, HEAT FLUX, TEMPERATURE MEASUREMENT, BUILDING CODES, THERMAL INSULATION.

MP 2836
DETECTION OF COARSE SEDIMENT MOVEMENT USING RADIO TRANSMITTERS.
Chacho, E.F., Jr., et al, *Northern engineer,* Fall 1990, 22(3), p.5-9, 8 refs. For another version see 44-3985.
Burrows, R.L., Emmett, W.W.
45-2099
SEDIMENT TRANSPORT, RIVER FLOW, TELEMETERING EQUIPMENT, ROCKS, GLACIAL RIVERS.
The use of radio transmitters to track and locate coarse sediment (39 millimeters or larger) was successfully demonstrated by tracking five individual rocks through a highly mobile, braided river system. Radio-implanted rocks traveling distances greater than 1,500 m in 8 days' time were tracked during periods of high flow and turbid water conditions. After flow receded and access to the bars and channels was possible, the rocks were again located and recovered even though burial of up to 0.3 m had occurred. A motion sensing device that detects whether a particle is in motion or at rest was also tested successfully.

MP 2837
ROLLER-COMPACTED CONCRETE PAVEMENT CONSTRUCTION AT FORT DRUM, NEW YORK.
Cortez, E.R., et al, *Transportation research record,* 1990, No.1282, p.8-17, 5 refs.
Gerlach, J.A.
45-2088
CONCRETE PAVEMENTS, FROST HEAVE, CONCRETE DURABILITY, FLEXURAL STRENGTH, COLD WEATHER CONSTRUCTION.

MP 2838
AIR TEMPERATURE VARIATION OVER SNOW-COVERED TERRAIN.
Hogan, A., et al, *Eastern Snow Conference. Proceedings,* 1990, 47th, U.S. Army Cold Regions Research and Engineering Laboratory. Special report SR 90-44. Edited by M. Ferrick and T. Pangburn, p.1-12, 26 refs.
Ferrick, M.G.
45-2182
AIR TEMPERATURE, TEMPERATURE VARIATIONS, SNOW COVER EFFECT, SNOW AIR INTERFACE, RIVER ICE, ICE AIR INTERFACE.
December 1989 was not only one of the coldest months for which instrumental records exist in the Northeastern United States, but was also unusual in that the air temperature remained continuously below freezing during all but the last day of the month. This prolonged cold period provided relatively homogeneous meteorological conditions in which to study the relationship among complex terrain variables and early morning air temperatures. An experiment was conducted in the Connecticut River Valley near 43N latitude, based on the hypothesis that the river pool above Wilder Dam would provide a homogeneous surface reference for comparison of air temperatures observed nearby in differing geographic settings. Temperatures were measured 1.5 m above the surface at 92 relocatable points along a 33 km north-south transect and 12 km east-west transect. Morning twilight temperatures measured on five days prior to a 30 cm snowfall on Dec. 16 were compared with temperatures at the same locations on the five following days. Prior to the snowfall, the temperatures near the river were higher than those immediately upslope by more than 2 C. This trend was reversed following the snowfall, with colder air near the river. An analysis is presented to demonstrate that the heat rejected from river ice growth would be sufficient to provide the observed local warming. The quantity of heat available from this source decreased by an order of magnitude coincident with the observed reversal in temperature trends near the river. The influences of terrain slope, vegetation and the "heat island" of a village are also discussed.

MP 2839
MICROSCOPIC OBSERVATIONS OF SNOW DEFORMATION.
Shoop, S.A., et al, *Eastern Snow Conference. Proceedings,* 1990, 47th, U.S. Army Cold Regions Research and Engineering Laboratory. Special report SR 90-44. Edited by M. Ferrick and T. Pangburn. p.27-38.
Taylor, S.
45-2184
SNOW STRENGTH, SNOW DEFORMATION, SNOW COMPRESSION, MICROANALYSIS, SNOW COVER STRUCTURE, TRAFFICABILITY.
Snow grains subjected to shearing or compressive forces, or both, were examined with a microscope to explore the conditions that cause melting of grains during snow deformation. Researchers have studied the deformation of snow, caused by wheels, tracks, sliders and skis, but little work has been done on snow deformation at a microscopic scale. This information is useful in defining the processes involved in snow deformation and is applicable to research on vehicle mobility and construction on snow, skiing and avalanches. Snow samples were deformed using a variety of instruments and studied via thin sections and single grain observations. In general, the sheared zones contained broken grains, crushed material and aggregates of crushed material. Evidence of melting was observed immediately adjacent to sheared surfaces, and when the pressure and temperature conditions were conducive to pressure melting. Snow with large, rounded grains showed changes from deformation most clearly.

MP 2840
RECENT DEVELOPMENTS IN SNOW-CHEMISTRY RESEARCH IN THE WESTERN UNITED STATES.
Davis, R.E., et al, *Eastern Snow Conference. Proceedings,* 1990, 47th, U.S. Army Cold Regions Research and Engineering Laboratory. Special report SR 90-44. Edited by M. Ferrick and T. Pangburn, p.99-107, 13 refs.
Bales, R.C.
45-2190
SNOW COMPOSITION, SNOW IMPURITIES, SNOWMELT, WATER CHEMISTRY, CHEMICAL COMPOSITION, GAS INCLUSIONS, MATHEMATICAL MODELS.
Three active areas of detailed research in snow and ice chemistry are described with emphasis on the connection between processes at different scales: i) modeling chemical hydrographs from seasonal snowpacks in alpine watersheds, ii) studying processes affecting ion redistribution in, and elution from snow, and iii) investigating the interaction of trace gases in snow. First, in alpine watersheds where snowmelt runoff dominates basin hydrology, accurate hydrochemical modeling depends on developing adequate descriptions of snowmelt chemistry. Whole-watershed hydrochemical modeling using point descriptions of snowmelt chemistry, along with distributed estimates of snowmelt volume, is being pursued for the Emerald Lake (Sierra Nevada) and other alpine watersheds in the western U.S. Second, tracer studies at the Sierra Nevada Aquatic Research Laboratory are being used to develop point estimates of snowmelt volume versus chemistry for use in the distributed watershed models. Complementary field studies are ongoing at the U.S. Forest Service's Glacier Lakes site in Wyoming, and the Mammoth Mountain (California) field site of the University of California, Santa Barbara. Third, recent studies by researchers at the University of Arizona and the U.S. Forest Service have used chromatographic methods to examine the interaction of reactive gases (SO_2, H_2O_2) with ice surface, continuing earlier investigations of gaseous deposition to snow.

MP 2841
PROTOTYPE PHYSICALLY-BASED MODEL FOR THE PREDICTION OF THE SPATIAL DISTRIBUTION OF SNOWCOVER.
Sambles, K.M., et al, *Eastern Snow Conference. Proceedings,* 1990, 47th, U.S. Army Cold Regions Research and Engineering Laboratory. Special report SR 90-44. Edited by M. Ferrick and T. Pangburn, p.109-119, 22 refs.
Harrison, A.R., Anderson, M.G., Pangburn, T.
45-2191
SNOW COVER DISTRIBUTION, SNOW DEPTH, SNOWMELT, RUNOFF FORECASTING, MATHEMATICAL MODELS, DATA PROCESSING.
A prototype digital model, SNOMO, has been developed to predict the pattern of snowcover and snowdepth distribution over a small catchment during the melt season. The catchment is subdivided into homogeneous areas on the basis of elevation, slope angle, aspect and vegetation cover using a GIS driven algorithm. The energy budget of the snowpack is calculated for each area. A simplified version of the snowpack internal structure and characteristics is used to alleviate data availability problems. The energy-budget terms are used to calculate the amount of melt, which is then subtracted from the existing snowpack depth in terms of centimeters of snow. The model has been tested on the W3 watershed (8.4 sq km), part of Sleepers River Research Watershed, Danville, VT. Point predictions are shown to accord well with observed values, and spatial predictions of snow distributions for the complete catchment are presented.

MP 2842
REGIONAL SNOWFALL INTENSITY AND THE GREAT LAKES ANOMALY.
Ryerson, C.C., et al, *Eastern Snow Conference. Proceedings,* 1990, 47th, U.S. Army Cold Regions Research and Engineering Laboratory. Special report SR 90-44. Edited by M. Ferrick and T. Pangburn, p.189-199, 14 refs.
Bates, R.E.
45-2198
SNOWFALL, SNOWSTORMS, LAKE EFFECTS, SYNOPTIC METEOROLOGY.
Snowfall intensity widely varies spatially and temporally within individual storms and within regions. However, regional snowfall intensity has not been mapped or characterized systematically as a climatic phenomenon. Snowfall intensity was compiled and mapped over the continental United States from four years of National Weather Service 6-hour synoptic reports to show general patterns. Intensities are generally greatest in both eastern and western mountain areas and along the East Coast, and are generally lowest in the northern Plains and Great Lakes. The low Great Lakes intensities were unexpected because of the frequent lake-effect storms along their southeast shores. Methodological and meteorological reasons for this pattern are discussed, and methods of resolving whether the Great Lakes patterns are true are suggested.

MP 2843
PERFORMANCE OF AN OMNIDIRECTIONAL WHEEL ON SNOW AND ICE.
Blaisdell, G.L., *Naval engineers journal,* Jan. 1991, 103(1), p.34-41, 7 refs.
45-2227
VEHICLE WHEELS, SNOW COVER EFFECT, ICE COVER EFFECT, MECHANICAL TESTS, PERFORMANCE, TRACTION, DESIGN, AIRCRAFT LANDING AREAS.
This study investigated the suitability of service vehicles equipped with a unique omnidirectional wheel operating aboard aircraft carriers in northern latitudes, where ice and snow on flight decks is not uncommon. It addressed the comparative performance of the omnidirectional wheel, a bias-ply highway tire as used on current Navy MD-3 aircraft tow vehicles, a typical nonpneumatic forklift truck tire, and an automotove radial-ply all-season tire. The tires were tested for driving traction levels on prepared ice, hard-packed snow, and fresh shallow snow. In general, the omnidirectional wheel showed performance superior to the forklift truck tire and the bias-ply highway tire. The radial all-season tire, however, outperformed the omnidirectional wheel in traction on slippery surfaces. The omnidirectional wheel was well-behaved during traction testing and shows promise for operation on winter surfaces. Recommendations are provided that might further improve omnidirectional wheel performance on snow and ice.

MP 2844
STABILITY OF FLOATING AND SUBMERGED BLOCKS.
Daly, S.F., et al, *Journal of hydraulic research,* 1990, 28(6), p.737-752, With French summary. 13 refs.
Axelson, K.D.
45-2257
SIMULATION, FLOATING ICE, UNDERWATER ICE, STABILITY, FLUID FLOW, HYDRODYNAMICS, PHYSICAL PROPERTIES, ANALYSIS (MATHEMATICS), ICE FORECASTING.
The rotational stability of floating and submerged rectangular blocks is described. The limit of stability is reached when

the underturning moment acting on the block is equal to the maximum hydrostatic righting moment. The hydrostatic righting moment is derived and a convenient expression for its maximum is presented in nondimensional form. A moment coefficient is defined that relates the underturning moment at the limit of stability to the moment produced by the product of the dynamic pressure of the flow and the plan area of the block. An exponential function of the ratio of block thickness to flow depth is postulated as a general expression for the moment coefficient. The parameters of this function are related to the block geometry by analyzing the existing experimental data. The limit of rotational stability for rectangular blocks can then be described in terms of a densimetric Froude number based on block thickness.

MP 2845
COLD REGIONS ENGINEERING.
International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991, New York, American Society of Civil Engineers, 1991, 790p., Refs. passim. For individual papers see 45-2317 through 45-2387.
Sodhi, D.S., ed.
45-2316
SOIL FREEZING, FROZEN GROUND STRENGTH, WATER TREATMENT, FROST ACTION, COLD WEATHER CONSTRUCTION, RIVER ICE, ICE MECHANICS, ICE STRENGTH, SNOWDRIFTS, ICE WATER INTERFACE, ICE LOADS, ICE DETECTION, RECORDING INSTRUMENTS.

MP 2846
LABORATORY METHODS FOR PREPARING LOW-DENSITY FROZEN SALINE SOIL SAMPLES FOR STRENGTH TESTS.
Ayorinde, O.A., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.32-43, 2 refs.
45-2320
SOIL FREEZING, FROZEN GROUND STRENGTH, ARTIFICIAL FREEZING, ARTIFICIAL ISLANDS, SALINE SOILS, OFFSHORE STRUCTURES, ANALYSIS (MATHEMATICS), EARTH FILLS.
Laboratory methods were developed for preparing low-density frozen saline soil samples with density values ranging from 85-110 lb/cu ft. This range of density values is typical of below-water fill for winter-constructed arctic islands and causeways. These low-density frozen saline soil samples were used for triaxial-compression consolidated-drained (CD) tests to estimate the island/causeway strength. Two laboratory methods found adequate for low-density frozen samples were (a) backsaturating compacted freshwater frozen-soil chunks or lumps with seawater at the freezing temperature, and (b) depositing and consolidating freshwater frozen-soil chunks in a seawater column maintained at the freezing temperature.

MP 2847
LABORATORY STUDY OF SHOCK WAVES IN FROZEN SOIL.
Dutta, P.K., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.54-70, 27 refs.
Farrell, D., Kalafut, J.
45-2322
FROZEN GROUND MECHANICS, FROZEN GROUND STRENGTH, SHOCK WAVES, LABORATORY TECHNIQUES, ANALYSIS (MATHEMATICS).
This work has focused on two aspects of dynamic behavior of frozen soil: first, on the shock pressure attenuation, and second, on the shock Hugoniot. The use of long bars of frozen soil mounted with a stress transfer cap mated to the Hopkinson pressure bar was investigated as a technique for shock attenuation studies. Hugoniot shock data were obtained from the high stress level impact on the specimens in the Hopkinson pressure bar (HPB) by applying the elementary theory of unidirectional stress propagation. Wave attenuation from low-level impact was exponential but the results are suspected to be influenced by wave dispersion and shear deformation effects. Hugoniot data were obtained over only a small deformation range, owing to the short (250-microsecond) wavelength developed by the HPB apparatus.

MP 2848
SLUDGE DEWATERING IN FREEZING BEDS.
Martel, C.J., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.108-115, 6 refs.
45-2326
SLUDGES, ARTIFICIAL FREEZING, WATER TREATMENT, FREEZE DRYING, ARTIFICIAL THAWING.
This paper summarizes the results of laboratory and pilot scale studies on the development of the sludge freezing bed. Laboratory studies indicated that a freezing bed could dewater up to 2.0 m of typical water and wastewater sludges. Pilot plant results indicated that adequate drainage during thaw was critical for odor control. After thawing, the sludge was dry enough for removal with mechanical equipment. The cost of constructing a freezing bed was estimated to be considerably higher than that of an equivalent drying bed. However, this extra expense would be more than offset by higher loading rates and lower operation and maintenance costs.

MP 2849
FREEZE-THAW EFFECTS ON CLAY COVERS AND LINERS.
Chamberlain, E.J., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.136-151, 18 refs.
Ayorinde, O.A.
45-2329
WASTE DISPOSAL, CLAY SOILS, FREEZE THAW CYCLES, PERMEABILITY, SOIL FREEZING, SOIL STABILIZATION, SOIL COMPACTION.
This report reviews laboratory experiments on the effects of freezing and thawing on the permeability of clayey soils and develops compaction requirements to minimize damage to clay layers caused by freezing and thawing. Permeability increases greater than two orders of magnitude have been observed. The smallest changes in permeability occurred when the soils were compacted to high densities. The authors show how a relationship between the percent increase in permeability and the liquidity index of the soil affects the acceptable range of moisture contents and densities required for compaction. A simple method for estimating the acceptable zone based on the plastic limit and the degree of saturation is also provided.

MP 2850
THERMAL REGIME SURROUNDING A LONGITUDINAL EDGE DRAIN.
Allen, W.L., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.164-177, 3 refs.
45-2331
SEASONAL FREEZE THAW, RUNWAYS, DRAINS, DRAINAGE, PAVEMENTS, WATERPROOFING, FROST HEAVE.
Newton Airfield in Jackman, Maine, was constructed in 1986 to perform as a drained pavement system. The drainage design consisted of a permeable base course with a longitudinal edge drain along one side of the runway. The drain was placed 5 1/2 to 7 ft below the pavement surface to provide service throughout the freezing season. Initial observations of the site showed that during the winter, outflow from the drain outlet stops. Problems with the performance of the system were observed in the form of water coming up through the pavement surface and flowing over the top of the pavement. A hypothesis was proposed that frozen soil material was blocking the flow of water into the drain structure. Instrumentation placed to monitor the ground freezing regime around the drain indicated that the drainage system and the pavement structure thaw relatively quickly. A closer look at the pavement geometry and the permeability of the base course indicated that the base course cannot provide the flow capacity to drain the water available from snow melt during the spring thaw period.

MP 2851
NUMERICAL ANALYSIS OF FROST SHIELDS.
Coutermarsh, B.A., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.178-190, 12 refs.
Phetteplace, G.
45-2332
FROST PROTECTION, THERMAL INSULATION, MATHEMATICAL MODELS, UNDERGROUND PIPELINES, FROST PENETRATION, PIPELINE INSULATION, SOIL FREEZING.
A finite element heat transfer program has been developed to assess the practicality of currently used frost shielding techniques by allowing the designer to model frost penetration using different burial depths, insulation schemes and backfill materials around the utility line. The information obtained is then used to perform an economic analysis on the possible schemes to determine the most cost-effective solution to the problem. This paper discusses the program development and rationale. Also discussed are the particulars of finite element modeling and the necessary precautions that must be followed when this method is used. Verification is demonstrated by numerical approximation with analytical solutions and by presenting actual frost penetration data obtained under controlled conditions in the CRREL Frost Effects Research Facility. Some sample results for promising frost shield applications are presented along with an example of the cost savings possible.

MP 2852
COMPUTER PREDICTIONS OF THAW BENEATH GRAVEL EMBANKMENTS ON WARM PERMAFROST.
Bigl, S.R., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.191-199, 7 refs.
Berg, R.L.
45-2333
COMPUTERIZED SIMULATION, EMBANKMENTS, PERMAFROST BENEATH ROADS, GROUND THAWING, THAW DEPTH.
The model, using a one-dimensional finite-difference code, FREZID, predicted that a gravel embankment can be constructed on an ice-rich clay permafrost without generating excessive amounts of thaw settlement. Gravel embankments thicker than 19 ft are predicted to contain thaw penetrations for a 10-yr period experiencing air temperatures similar to the 1976-86 decade. Thinner embankments will require additional treatments to prevent thaw from penetrating the permanently frozen clay. Inclusion of extruded polystyrene insulation at 2 ft below the gravel surface was extremely effective in reducing thaw penetration depths.

MP 2853
NEW ADMIXTURES FOR COLD WEATHER CONCRETING.
Korhonen, C.J., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.200-209, 7 refs.
Cortez, E.R., Smith, C.E., Jr.
45-2334
WINTER CONCRETING, CONCRETE ADMIXTURES, ANTIFREEZES, CONCRETE STRENGTH, CONCRETE CURING.
Chemicals were tested for their ability to promote strength gain in portland cement concrete at low temperature. The admixtures depressed the freezing point of the mix water and accelerated the hydration of cement at low temperature. Tests were conducted at 20, -5 and -10 C. The results show that low-temperature strength gain of antifreeze concrete can be comparable to that of additive-free concrete cured at room temperature. These additives, so-called "antifreeze admixtures" have potential for use in the cold regions.

MP 2854
PROCESSED-SNOW FOUNDATION DESIGN AT THE SUMMIT OF THE GREENLAND ICE CAP.
Curtis, K.C., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering. New York, American Society of Civil Engineers, 1991, p.240-249.
Tobiasson, W.
45-2337
SNOW (CONSTRUCTION MATERIAL), SNOW STABILIZATION, FOUNDATIONS, EMBANKMENTS, RESEARCH PROJECTS, ICE SHEETS, SNOW COMPACTION, GREENLAND.
The design and construction of a processed-snow foundation berm for an elevated building located at the summit of the Greenland Ice Cap is described. Weather conditions and design provisions at the Greenland Ice Sheet Project (GISP) 2 site are described. Undisturbed snow densities are compared to processed-snow densities measured in the compacted foundation berm.

MP 2855
EVOLUTION OF ICE COVER ROUGHNESS.
Ashton, G.D., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.294-305, 11 refs.
Zufelt, J.E.
45-2341
RIVER ICE, ICE FORMATION, SURFACE ROUGHNESS, ICE BOTTOM SURFACE, ICE COVER THICKNESS, RIVER FLOW, ICE COVER EFFECT, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS).
The formation of an ice cover on a river results in an increase of stage relative to open water stages at the same discharge. Due to the formation process, especially for freeze-up ice jams, the underside of the ice cover is very rough initially and smooths with time. Observations in the field have shown considerable reductions of stage or head loss with time. Three mechanisms responsible for the evolution of ice cover roughness are investigated: freeze smoothing, melt smoothing, and depositional smoothing. While these mechanisms have previously been noted as the

cause of smoothing with time, this paper presents quantitative estimates of the magnitude of roughness changes based on the physics of the three processes.

MP 2856

CONCEPTUAL MODEL FOR VERTICAL FRAZIL DISTRIBUTION IN TURBULENT FLOWS.

Liou, C.P., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.336-347, 30 refs.

Ferrick, M.G.

45-2345

FRAZIL ICE, ICE MODELS, TURBULENT FLOW, HEAT TRANSFER, ICE FORMATION, ICE WATER INTERFACE, MATHEMATICAL MODELS.

A conceptual model is presented for the evolution of frazil over depth in a turbulent flow. The net upward migration due to buoyancy of the frazil is opposed by intermittent mixing induced by large energy-containing eddies. A surface renewal model is adopted to describe the large eddy mixing. Averages over an ensemble of discrete local volumes for the concentration profile, surface age and surface layer thickness are obtained with a probability density function. A dimensionless surface renewal frequency characterizes the frazil distribution at equilibrium as either well-mixed or layered. The model provides a physical basis for understanding the transition between these conditions, and is consistent with existing empirical criteria and field data.

MP 2857

RIVER ICE MANAGEMENT (RIM) PROGRAM: DEVELOPING NEW OPTIONS FOR WATERWAYS OPERATIONS IN WINTER.

Carey, K.L., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.376-385, 7 refs.

45-2349

RIVER ICE, ICE CONTROL, ICE NAVIGATION, RESEARCH PROJECTS, CHANNELS (WATERWAYS), LOCKS (WATERWAYS), DAMS, MANUALS.

Most of the navigable inland waterways of the United States are utilized year-round. In northern portions of this network (mainly parts of the Ohio and Upper Mississippi River basins), ice reduces transportation efficiency and interferes with the operation of Corps of Engineers locks and dams. In parallel with Corps programs for rehabilitation or replacement of certain aging and inadequate locks and dams (averaging about 50 years old), the Corps' five-year River Ice management (RIM) Program developed ways to incorporate structural improvements in new and existing navigation projects, and examined new operational techniques, all aimed at improving waterway operations in the presence of the ice. RIM Program studies focused on four functional areas: a) improving ice-conditions information to aid decision-making by the Corps and the navigation industry; b) helping locks and dams cope with ice in winter operations; c) influencing river ice formation and movement; and d) easing winter navigation operations in the vicinity of Corps projects. Several RIM Program demonstrations provided immediate improvements to winter operations. An Engineer Manual was produced giving uniform direction to Corps Districts in matters involving river ice, and containing guidance for studies leading to River Ice Management Plans for specific basins, mainstem rivers, or tributaries.

MP 2858

SMALL-SCALE METEOROLOGY OF FREEZING PRECIPITATION.

Hogan, A.W., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.454-462, 8 refs.

45-2357

ICE STORMS, GLAZE, PRECIPITATION (METEOROLOGY), TOPOGRAPHIC EFFECTS.

Freezing rain and glazing are extremely disruptive to transportation, communication and power transmission. Local variations in the occurrence of freezing rain may be difficult to forecast. This paper describes terrain-induced temperature differences, and provides an analysis showing terrain-induced cold air retention during warm advection. Calculations indicate that it may be possible to locally ameliorate freezing rain in valleys with more than 300 m of local relief.

MP 2859

ANELASTIC STRAINING IN POLYCRYSTALLINE ICE.

Cole, D.M., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.504-518, 26 refs.

45-2362

ICE CRYSTAL STRUCTURE, ICE MECHANICS, ICE DEFORMATION, ICE ELASTICITY, ICE STRENGTH, ICE CREEP.

This paper presents experimental observations on the influence of stress, grain size and total strain level on the magnitude of anelastic strain in granular freshwater ice. Cyclic loading experiments carried out at low total strain levels indicate that the anelastic strain is a function of grain size. Strain recovery experiments, wherein the specimens were deformed to strains as high as 0.07, indicate that the anelastic strain reaches a maximum value at relatively low total strain levels and thereafter remains relatively constant. The results indicate for a given ice type, that when the total strain level is relatively high (e.g. >0.01), the anelastic strain is no longer a function of grain size, but only of temperature and stress level. A nonlinear relationship between the anelastic strain and applied stress level emerged for the strain recovery experiments. A dislocation-based model that explains the stress dependency is developed and is seen to represent the experimental observations reasonably well. The grain size dependency of the internal friction is explained qualitatively in terms of the structure of grain boundaries. Discussions center on the development of a unified dislocation-based view of the anelastic strain observed under all experimental conditions.

MP 2860

PRELIMINARY RESULTS OF DIRECT TENSION TESTS ON FIRST-YEAR SEA ICE SAMPLES.

Richter-Menge, J.A., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.569-578, 15 refs.

Claffey, K.J.

45-2367

SEA ICE, ICE STRENGTH, STRAIN TESTS, TENSILE PROPERTIES, ICE MECHANICS, ICE LOADS, TEMPERATURE EFFECTS.

The initial results of the tests are presented to determine the tensile behavior of columnar sea ice over a range of temperatures extending from -20 to -3 C and strain rates of 100,000/s and 1000/s. The temperature of a test specimen was dictated by its in-situ location within the sheet; samples located near the top of the sheet were tested at the lower temperature. All samples were taken from the horizontal plane of the ice sheet. The maximum stress achieved during a test was most notably influenced by temperature, while loading rate was the primary variable in determining the failure strain and the modulus.

MP 2861

EFFECTIVE PRESSURES MEASURED DURING INDENTATION TESTS IN FRESHWATER ICE.

Sodhi, D.S., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.619-627, 7 refs.

45-2372

ICE STRENGTH, ICE PRESSURE, IMPACT TESTS, ICE DEFORMATION, ICE LOADS, ICE SOLID INTERFACE.

Indentation tests were conducted by pushing flat, vertical indentors of two different widths (50 and 100 mm) against the edges of floating freshwater ice at different velocities (0.6-150 mm/s). The stiffness of the indentor support system and the ice thickness were in the range of 0.8-3.5 MN/m and 18-57 mm, respectively. Three different modes of ice-structure interactions were observed: creep deformation at low velocities, intermittent crushing at intermediate velocities and continuous crushing at high velocities. The maximum effective pressures measured at different indentor velocities were found to differ by a factor of 3 to 5; high pressures (8-13 MPa) were measured at low indentor velocities (<20 mm/s), and low pressures (1.2-4.3 MPa) at high indentor velocities (>100 mm/s).

MP 2862

SPRAY AND ICE MEASUREMENT INSTRUMENTATION FOR SHIPS.

Ryerson, C.C., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.748-757, 5 refs.

Walsh, M.R., Knuth, K.V.

45-2384

SHIP ICING, SEA SPRAY, ICE DETECTION, THICKNESS GAGES, ICE FORECASTING, RECORDING INSTRUMENTS, MEASURING INSTRUMENTS.

Bow slamming is the primary water delivery mechanism for ship superstructure icing. Spray flux is largely dependent upon hull dynamics, and cannot be computed numerically with current understanding of hydrodynamic processes. Therefore, ship icing models must rely upon empirical algorithms for water delivery. The Cold Regions Research and Engineering Laboratory has developed an instrumentation system that automatically measures spray flux and ice growth for use in icing forecast model development and validation. Though the spray measurement system is similar in concept to a rain gauge and the ice measurement system is similar to an ultrasonic camera rangefinder, the systems are more complex because of their need to operate reliably on a ship deck in heavy weather. This paper describes the design, testing, construction, and fielding of this equipment.

MP 2863

USACRREL UNDERWATER FRAZIL ICE DETECTOR.

Daly, S.F., et al, International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.758-764, 1 ref.

Rand, J.H.

45-2385

UNDERWATER ICE, FRAZIL ICE, ICE DETECTION, RECORDING INSTRUMENTS.

A modified underwater frazil ice detector has been developed at USACRREL. This detector, which operates remotely, can automatically start deicing procedures and alert operators to the presence of frazil. The detector operates by monitoring the flow rate through a small intake screen. The intake screen is, in effect, a miniature trash rack that will allow frazil ice to accumulate much quicker than the actual trash racks. This patent-pending detector was tested in the laboratory and in field conditions. The system is an economical solution to the early detection of frazil ice.

MP 2864

RECOMMENDED COLD REGIONS METEOROLOGICAL INSTRUMENTATION.

Bates, R.E., International Cold Regions Engineering Specialty Conference, 6th, West Lebanon, NH, Feb. 26-28, 1991. Proceedings. Edited by D.S. Sodhi. Cold regions engineering, New York, American Society of Civil Engineers, 1991, p.772-783, 12 refs.

45-2387

METEOROLOGICAL INSTRUMENTS, WEATHER OBSERVATIONS, COLD WEATHER PERFORMANCE, HUMIDITY, AIR TEMPERATURE, WIND (METEOROLOGY), PRECIPITATION (METEOROLOGY).

The northern temperate climatic zones experience a varying scenario of winter environmental extremes of cold, icing, and precipitation, which severely influence people, equipment and operations. Even instruments designed to measure cold and/or wet adverse environments may be incapable of operation if employed during severe cold weather. It is important to know the equipment's environmental restrictions and to evaluate the frequency and duration of disabling weather. In some instances, functional impairments persist after the causative meteorological conditions have subsided, e.g., glaze, rime and heavy snow and ice accumulation. For nearly 30 years, CRREL has studied environmental conditions in winter weather. These efforts have concentrated on providing field-measured meteorological data, as well as instrumentation support for many experiments conducted throughout cold regions of the Northern Hemisphere. These efforts have involved characterizing atmospheric conditions as well as surface conditions. This paper will discuss instrumentation currently being used to gather atmospheric and background environmental data during winter field testing. Current state-of-the-art developments such as a new laser diode for measuring relative humidity will be discussed. Finally a brief summary of data gathered and data analysis methods will be presented.

MP 2865

HEAT TRANSFER WITH FREEZING AND THAWING.

Lunardini, V.J., Developments in geotechnical engineering, No.65, Amsterdam, Elsevier Science Publishers, 1991, 437p., Refs. passim.

45-2390

HEAT TRANSFER, PHASE TRANSFORMATIONS, ANALYSIS (MATHEMATICS), FREEZING, THAWING, LIQUID SOLID INTERFACES, BOUNDARY VALUE PROBLEMS, TEMPERATURE EFFECTS, SOIL FREEZING, GROUND THAWING, POROUS MATERIALS.

MP 2866

NEW WETTING CURVES FOR COMMON ROOF INSULATIONS.

Tobiasson, W., et al, International Symposium on Roofing Technology, 3rd, 1991. Proceedings. Building a worldwide roofing community, Rosemont, IL, National Roofing Contractors Association, 1991, p.383-390, 11 refs.

Greatorex, A., Van Pelt, D.

45-2461

ROOFS, THERMAL INSULATION, MOISTURE, VAPOR PRESSURE, TEMPERATURE EFFECTS, THERMAL CONDUCTIVITY.

Specimens of common roof insulations were placed in an apparatus that maintained an air temperature of 4 C and 75% relative humidity (RH) above the insulation, and 29 C and 100% RH (or 70% RH) below. The specimens were periodically removed from this apparatus, weighted, wrapped in a thin plastic film and then tested in a thermal conductivity instrument with its top plate maintained at about 4 C and its bottom plate at about 29 C. After a specimen's insulating ability was determined in this instrument according to the ASTM C 518-76 procedure, it was

returned to the apparatus for further wetting. Some insulations accumulated moisture rapidly, but others gained very little moisture even after years of testing. The ratio of a material's wet thermal resistivity to its dry thermal resistivity, expressed as a percentage, is termed its thermal resistance ratio (TRR). As moisture accumulates in a material, its TRR decreases. Graphs of TRR vs. moisture content were developed for fiberboard, perlite, cork, gypsum, insulating concrete, cellular glass, fibrous glass, expanded polystyrene, extruded polystyrene, urethane/isocyanurate, foamed-in-place urethane and phenolic insulations. TRR vs. moisture content equations have also been developed for each material. Insulation with a TRR of 80% or less is deemed 'wet' and unacceptable. The moisture content at which the TRR equals 80% is tabulated for these materials.

MP 2867
BANK RECESSION AND CHANNEL CHANGES NEAR DIKES ON THE TANANA RIVER, ALASKA.
Gatto, L.W., D.B. Simons Symposium on Erosion and Sedimentation. Proceedings. Edited by R.M. Li and P.F. Lagasse, American Society of Civil Engineers, 1983, p.4.2-4.21, 8 refs.
45-2492
WATER EROSION, CHANNELS (WATERWAYS), BANKS (WATERWAYS), BANK PROTECTION (WATERWAYS), RIVERS, UNITED STATES—ALASKA—TANANA RIVER.
Two dikes were built from the Tanana River levee into the Tanana River in 1975 and 1979 as part of a flood control project. New dikes will be constructed wherever it appears likely that bank recession will encroach into the 500 ft safe zone between the levee and the north bank of the river. The objectives of this analysis were to measure linear bank recession and bank land lost, to evaluate relationships between bank erosion and dike construction, and to describe channel changes before and after construction. Aerial photographs were used to map historical bankline positions and to document channel changes from 1948 to 1982. Most bank recession near the dikes occurred along the north channel prior to construction. After construction the dikes diverted flows away from the north bank, and bank erosion increased along the islands and south bank. Both dikes effectively reduced north bank erosion at sites immediately downstream. However, it appears that this solution may be temporary. The river is re-establishing its preconstruction length in the reaches where the dikes were built by forming meanders at the ends of the dikes. The river is again attacking the north bank downstream of the preconstruction locations, and erosion rates at some of these new sites are high.

MP 2868
IN SEARCH OF LIBRARY EXCELLENCE IN COLD REGIONS RESEARCH.
Liston, N.C., Education and continuing development for the civil engineer. New York, American Society of Civil Engineers, 1990, p.1066-1069.
45-2580
RESEARCH PROJECTS, DATA PROCESSING, BIBLIOGRAPHIES, EDUCATION, ORGANIZATIONS, COLD REGIONS.
In the age of the information explosion, engineers and librarians must work together to achieve a value-added research product. The importance of the librarian's role in the research process was never more important than it is today in a world of diminishing resources and expanding demands. This paper presents a special engineering librarian's view of how the information specialist will enhance the research process in the 1990s.

MP 2869
PREDICTION OF ERRORS FOR IN-SITU MEASUREMENT OF THERMAL RESISTANCE.
Flanders, S.N., et al, *U.S. Army Cold Regions Research and Engineering Laboratory. Special report,* Feb. 1991, SR 91-03, In-situ heat flux measurements in buildings; applications and interpretations of results. Edited by S.N. Flanders, p.193-219, ADA-234 924, 17 refs.
Mack, R.T.
45-2659
BUILDINGS, HEAT FLUX, TEMPERATURE MEASUREMENT, THERMAL CONDUCTIVITY, THERMAL INSULATION, COMPUTER PROGRAMS, MATHEMATICAL MODELS.
A sufficient measurement time is key to the accurate determination of thermal resistance from in-situ heat flux and temperature data. Given some assumed thermal properties of the construction to be measured, this paper presents a means for predicting an error that might result from anticipated temperature conditions or for estimating the error that may be attributable to a temperature history. The error-prediction procedure is useful for deciding in advance whether to make in-situ thermal resistance measurements, during expected temperature conditions, of buildings and of structures that contain hot or cold media. This procedure estimates errors in the calculation of thermal resistance only, that result from obtaining non-steady-state temperature and heat flow data over a finite period of time. Random errors due to instrumentation techniques should be analyzed separately, using propagation of errors or other methods. Errors that result from changes in the apparent thermal conductivity of the constituent materials of the element studied are also beyond the scope of this paper. Such changes may be due to variation in internal temperatures, moisture migration or air movement.

MP 2870
THERMISTOR-BASED SYSTEM FOR THERMAL CONDUCTIVITY MEASUREMENT.
Atkins, R.T., et al, *U.S. Army Cold Regions Research and Engineering Laboratory. Special report,* Feb. 1991, SR 91-03, In-situ heat flux measurements in buildings; applications and interpretations of results. Edited by S.N. Flanders, p.223-236, ADA-234 924, 7 refs.
Wright, E.A.
45-2660
THERMAL CONDUCTIVITY, TEMPERATURE MEASUREMENT, THERMISTORS, ANALYSIS (MATHEMATICS), THERMAL INSULATION, SOIL TEMPERATURE, SLUDGES.
This report describes a patented method for using commercially available thermistors to make in-situ thermal conductivity measurements with commonly available electronic equipment such as digital voltmeters. The emphasis is on the use of a single thermistor to measure the thermal conductivity of soils. Calibration techniques are explained and examples provided. Limits on this technique are discussed, including measurement range, material grain size, the amount of material needed for a valid measurement, and temperature stability. Specific examples of the use of this technique are provided for thermal conductivity measurements of soils, building materials, and the sludges in a sewage treatment plant. Data analysis is provided, including a statistical approach to finding the thermal conductivity in large volumes of material.

MP 2871
LAYERED CHARACTER OF SNOW COVERS.
Colbeck, S.C., *Reviews of geophysics,* Feb. 1991, 29(1), p.81-96, 99 refs.
45-2828
SNOW STRATIGRAPHY, SNOW COVER STRUCTURE, METAMORPHISM (SNOW), SNOW HYDROLOGY, SNOW MECHANICS.
Snow studies have generally ignored the layered nature of snow covers. Having achieved a good understanding of the properties and processes in homogeneous snow, snow scientists should develop more insight into the evolution of the layers and their effects on overall snow response. Many of the outstanding problems in snow studies can only be solved by dealing with snow as a layered medium. The various mechanisms by which layers are generated, their effects, and some of the outstanding research problems are described here.

MP 2872
SURFACE RADAR INVESTIGATIONS OF AN ICING MOUND ON THE SAGAVANIRKTOK RIVER, ALASKA.
Arcone, S.A., et al, International Conference on Ice Technology, 2nd, Cambridge, England, Sep. 18-20, 1990. Proceedings. Edited by T.K.S. Murthy, J.G. Paren, W.M. Sackinger and P. Wadhams, Southampton, England, Computational Mechanics Publications, 1990, p.353-363, 9 refs.
Chacho, E.F., Jr., Collins, C.M., Delaney, A.J.
45-2744
RIVER ICE, FROST MOUNDS, WATER STORAGE, DETECTION, RADAR ECHOES, ICE SURVEYS, ICE WATER INTERFACE, SUBSURFACE INVESTIGATIONS, WATER RESERVES.
A short-pulse radar survey was carried out on the surface of a water-bearing icing mound on the Sagavanirktok River on Alaska's North Slope in Apr., 1989. The purpose was to map the extent of the subsurface water-filled cavity contained within the icing mound formation. Such mounds represent a possible winter water resource for exploration and development activities. The investigated mound was approximately 2.3 m high and over 110 m long. All radar profiles, made both parallel and perpendicular to the long axis of the mound, recorded water surface reflections, but only along the ends of the longitudinal profile were reflections received from the bottom of the water cavity; apparently rugged bottom relief prevented signals from being received from the water bottom. Snow depth and ice surface elevation were measured along all cross sections, and ice thickness and water depth were measured at a few locations along the cross sections. The radar data were then used with the drilling data to estimate the shape and dimensions of the water cavity. It appears that the mound was located in a small meander bend of one of the channels, with the cavity positioned over the pool and extending to the riffles at both ends. The water volume is estimated at about 900 cu m.

MP 2873
PARTICLE BEAM SIMULATION.
Hopkins, M.A., Mechanics computing in 1990s and beyond, New York, American Society of Civil Engineers, 1991, p.1274-1278, 5 refs. Proceedings of the ASCE conference, Columbus, OH, May 2-22, 1991.
45-2829
ICE JAMS, PRESSURE RIDGES, COMPUTERIZED SIMULATION, MATHEMATICAL MODELS.
A two-dimensional beam simulation is developed in which the beam is composed of uniform rectangular blocks. Internal forces in the beam are caused by relative motion between adjoining blocks. A viscous-elastic-plastic force model is used. Tensile or compressive failure of the beam occurs when stresses in the top or bottom surfaces exceed the strength of the material. The simulation is numerically explicit and completely consistent with existing discrete particle simulations. For this reason, it is especially suited for modeling problems in which a beam undergoes periodic failure, creating a rubble accumulation as blocks are broken from the parent beam. Two such problems are ice jamming in northern rivers and sea ice ridging in the Arctic.

MP 2874
VERNAL ATMOSPHERIC MIXING IN THE ANTARCTIC.
Murphey, B.B., et al, *Journal of applied meteorology,* Apr. 1991, 30(4), p.494-507, 54 refs.
Hare, T., Hogan, A.W., Lieser, K., Toman, J., Woodgates, T.
45-2842
AEROSOLS, STORMS, CLOUDS (METEOROLOGY), WEATHER OBSERVATIONS, OZONE, ANTARCTICA—MCMURDO STATION, ANTARCTICA—AMUNDSEN-SCOTT STATION.
Aerosol concentration, ozone concentration, and meteorological parameters were measured at McMurdo and South Pole Stations during a spring storm that reached the antarctic interior. Nacreous clouds were sighted preceding the storm, indicative of stratospheric flow from lower latitudes. These measurements and observations, along with upper-air and surface analyses, indicate that vigorous tropospheric/stratospheric exchange of air occurs near 75S during the spring. The elemental composition of collected aerosol changed coincidently with different stages of the storm. During the storm event in Sep. 1983, surface ozone concentration varied from 20 to more than 100 ppbv at McMurdo, but remained less than 20 ppbv at the South Pole indicating that deep mixing, which occurred at the periphery of Antarctica during the spring storm, did not continue over the interior of the continent. The warm marine air associated with the spring coastal storm infiltrated the interior of Antarctica including the Polar Plateau, producing a record surface temperature and an aerosol concentration twice the September mean. This system was unusual as the warm front apparently reached the surface of South Pole. Crustal material was transported to the periphery of Antarctica through the upper troposphere or lower stratosphere. Enhanced aerosol concentration was transported to the South Pole through the lower troposphere. Vigorous exchange occurred at latitudes of greater than 78S, which probably exchanged both marine aerosol and water vapor into the lower stratosphere. (Auth.)

MP 2875
ICE CONDITIONS ON INLAND WATERWAYS.
Frankenstein, G.E., et al, International Navigation Congress, 27th, Osaka, Japan, May 20-26, 1990. Proceedings, Brussels, Permanent International Association of Navigation Congresses, [1990], p.61-65, With French summary. 16 refs.
Rand, J.H., Wortley, C.A.
45-2647
RIVER ICE, ICE CONTROL, ICE CONDITIONS, ICE NAVIGATION, FRAZIL ICE, CHEMICAL ICE PREVENTION, ELECTRIC HEATING, LOCKS (WATERWAYS).

MP 2876
PHASE-CHANGE NUMERICAL HEAT TRANSFER ANALYSIS WITH APPLICATIONS TO FROST SHIELDING.
Farag, I.H., et al, *Heat transfer engineering,* 1991, 12(2), p.29-36, 26 refs.
Virameteekul, N., Phetteplace, G.E.
45-2915
PHASE TRANSFORMATIONS, HEAT TRANSFER, THERMAL INSULATION, FROST PROTECTION, MATHEMATICAL MODELS, FREEZING FRONT, UNDERGROUND PIPELINES.
A computer package has been developed to solve heat transfer problems with phase change and predict the temperature distribution and phase-front location variation with time. The fixed-mesh package incorporates latent heat effects. The time-domain solution uses a central-difference procedure. Published results on freezing of slab-shaped foodstuffs, solidification in an internal corner, a solidification outside a 270 deg wedge, and solidification of cast steel are used to demonstrate the validity of the numerical technique and the capabilities of the program. Underground freezing of pipelines with and without frost shields is studied using this package, and the results are discussed.

MP 2877
BANK AND CHANNEL CHANGES NEAR DIKES, TANANA RIVER, ALASKA.
Gatto, L.W., River meandering. Conference Rivers '83, New Orleans, LA, Oct. 24-26, 1983. Proceedings. Edited by C.M. Elliott, New York, American Society of Civil Engineers, 1983, p.212-222, 5 refs.
45-2957
BANKS (WATERWAYS), CHANNELS (WATERWAYS), EROSION.

Two dikes on the Tanana River diverted river flow away from the north bank which stopped north bank erosion immediately downstream of the dike locations, and bank erosion increased along some of the southern channels. The river, however, appears to be reestablishing its preconstruction length by forming meanders at the ends of the dikes, and is eroding the north bank downstream of the sites that were eroding prior to construction. Statistical analysis of erosion and discharge data showed that bank erosion increases the longer the discharge is above 30,000 cfs (840 cu.m./s). Although cross-sectional areas of the channels did not change substantially, major lateral shifts occurred in the northern channels. Most north channel changes occurred on the rising limb of the discharge hydrograph, while the south channel changed most as discharge receded. Data from this analysis and other studies will be used in selecting sites for additional dikes.

MP 2878
PROCEEDINGS. VOL.4.
International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991, New York, American Society of Mechanical Engineers, 1991, 287p., Refs. passim. For individual papers see 45-3141 through 45-3180.
Ayorinde, O.A., ed, Sinha, N.K., ed, Nixon, W.A., ed, Sodhi, D.S., ed.
45-3140
OFFSHORE STRUCTURES, ICE (CONSTRUCTION MATERIAL), ICE SOLID INTERFACE, OFFSHORE DRILLING, ENGINEERING, ICE LOADS, ICE MECHANICS, MATHEMATICAL MODELS, SEA ICE, ICE STRENGTH, ICE ISLANDS.

MP 2879
APPROXIMATE ANALYSIS OF THE TEMPERATURE DISTRIBUTION IN COMPOSTING MATERIAL IN A COLD ENVIRONMENT.
Ayorinde, O.A., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.87-92, 25 refs.
Lunardini, V.J.
45-3153
TEMPERATURE DISTRIBUTION, ANALYSIS (MATHEMATICS), COLD WEATHER TESTS.
An approximate analytical solution method was developed to quantify the distribution of temperatures in a compost pile at different low temperatures. Since composting is a temperature self-limiting process, the analysis of the temperature distribution of a compost pile in a cold environment is essential and desirable. The theoretical temperature distribution within the compost pile was calculated using an approximate analytical solution of the conductive heat transfer equation with a term for heat generated by microbial activity. For the analysis the composting material was considered to be homogeneous, which is a reasonable assumption since thorough mixing is always required for composting systems. In addition an idealized cylindrical shape was assumed, which is a good approximation for most reactor-type compost piles. Effects of ambient temperature, compost initial temperature and thermal diffusivity were also determined. Forced and free convective heat transfer effects were also evaluated. Published data on the heat production rate for different composting materials were used to estimate temperature distributions. The approximate analytical solution helps to identify significant parameters and to evaluate their influence on the performance of the composting system. The exact solution also provides a means of quantifying the distribution of microbially produced heat in the composting material. This type of solution, coupled with information on the effects of the environment on by-product fate and toxicity, could be used to guide optimal designs for cost-effective compost systems.

MP 2880
LABORATORY TESTS WITH A HYBRID THERMOSYPHON.
Haynes, F.D., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.93-99, 10 refs.
Zarling, J.P., Quinn, W.F., Gooch, G.E.
45-3154
PIPES (TUBES), SOIL STABILIZATION, FLUID FLOW, HEAT TRANSFER, FOUNDATIONS, PERFORMANCE, DESIGN, THERMAL CONDUCTIVITY, THAW DEPTH.
A passive-active thermosyphon, equipped with an internal condensate return device that delivered 70% of the condensate to the far end of the horizontal evaporator section, was tested in the laboratory. In the passive mode, the test variable was the wind speed across the vertical condenser section as the air temperature was held constant at -8 C. In the active mode, mechanical refrigeration lines were connected to a heat exchanger built into the standard commercial thermosyphon. The test variables in the active mode were air temperature and the mass flow rate of the refrigerant. A hybrid thermosyphon has the advantages of both a passive unit and an active unit.

MP 2881
QUANTIFYING THE EFFECT OF SPATIAL VARIABILITY IN INSULATION MOISTURE CONTENT PROFILES USING A NONDESTRUCTIVE TECHNIQUE.
Ayorinde, O.A., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.101-105, 6 refs.
Pidgeon, D.
45-3155
THERMAL INSULATION, MOISTURE TRANSFER, COLD WEATHER CONSTRUCTION.
A nondestructive technique using a dual-energy gamma-ray (DEGR) device was successfully applied to accurately measure the moisture profiles across the thicknesses of three types of insulation material exposed to water and subjected to a constant temperature gradient. The three types of insulation were expanded-bead polystyrene, urethane and perlite. The nondestructive method has also been used to continuously track and measure moisture migration and distribution in the insulating materials under prolonged exposure to moisture and thermal gradients. Similar measurements cannot be done by current destructive methods of determining insulation moisture profiles by a post-test slicing or cutting of the insulation. For this study a DEGR device was also used to evaluate the spatial variability in the across-thickness moisture profiles at three locations along the length of each insulation slab. The moisture profiles were measured at the midpoint (center) and at the quarter points (three inches left and right of the midpoint) along the insulation length. The average moisture contents at the three locations were also determined by calculating the across-thickness statistical mean values at these locations. The average of the mean values at the three locations was compared with the gravimetrically determined average moisture content for each type of insulation. The experimental results and analysis indicated that, for all the types of insulation tested, there were noticeable changes in the moisture profiles and average moisture contents at the three locations along the insulation length, showing the effect of spatial variability. The results also showed that the spatial variability in the moisture content profile depends on the type of insulation. Compared with the four-week gravimetric average volumetric moisture content of 0.115 cu cm/cu cm for polystyrene, the average volumetric moisture content was 0.137 cu cm/cu cm at the left quarter point, 0.129 cu cm/cu cm at the midpoint and 0.101 cu cm/cu cm at the right quarter point along the insulation length. For urethane the gravimetric value was 0.071 cu cm/cu cm compared to 0.081 cu cm/cu cm, 0.079 cu cm/cu cm and 0.067 cu cm/cu cm, respectively, at similar locations. However, for perlite the average volumetric moisture content was 0.274 cu cm/cu cm, 0.294 cu cm/cu cm and 0.285 cu cm/cu cm, respectively, at these locations compared to the gravimetric value of 0.306 cu cm/cu cm. This type of evaluation can be achieved only by a nondestructive technique.

MP 2882
SMALL-SCALE EXPERIMENTS ON SPLITTING OF ICE FLOES.
Sodhi, D.S., International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.171-175, 13 refs.
45-3166
ICE FLOES, ICE SOLID INTERFACE, ICE CRACKS, VELOCITY, ICE COVER THICKNESS.
When small-scale indentation tests were conducted by pushing a flat, vertical indentor against the edges of floating freshwater ice sheets at low velocities, a macrocrack always formed in front of the indentor. When the indentor was made to impact against free-floating ice floes at high velocities, the floes did not split. The difference in these results is attributed to the different modes of ice deformation at different indentor velocities relative to ice. For low velocity tests, the ratio of crack opening force to ice pushing force is estimated from experimental data and existing theoretical results in the literature.

MP 2883
FIELD OBSERVATIONS OF STRESSES IN YOUNG ICE.
Perovich, D.K., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.191-198, 17 refs.
Tucker, W.B.
45-3169
PACK ICE, YOUNG ICE, STRESSES, SEA ICE.
An accurate understanding of in-situ pack ice forces is of critical importance in improving ice forecasting models and in generating estimates of loads on offshore structures. Young ice plays an important but poorly understood role in determining the internal stress field in sea ice. For one month, in-situ ice stress measurements were obtained in young first-year ice in the eastern Arctic during the fall of 1988. Sensors were also placed in an adjacent multi-year floe. During extreme deformation events, peak stresses briefly reached 400 kPa in both the young ice and in multi-year ice. During periods of dynamic activity, stresses in young ice and in multi-year ice were well correlated. Typically, stresses were largest in the young ice and were rapidly attenuated with distance from the edge of the multi-year floe. From day 314 to 320, twice daily oscillations of about 50 kPa due to tides or inertial oscillations were apparent in the stress data.

MP 2884
EVALUATION OF AN IMPACT TEST FOR MEASURING ICE ADHESION STRENGTH.
Andersson, L.O., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.215-220, 19 refs.
Lever, J.H., Mulherin, N.D., Rand, J.H.
45-3172
ICE ADHESION, IMPACT TESTS, IMPACT STRENGTH.
Lack of standardized testing has hampered efforts to understand ice adhesion and develop low-adhesion materials. However, the American Society for Testing and Materials (ASTM) specifies numerous standards for testing adhesive joints. The authors plan to adopt one of these standards for ice-adhesion tests, with ice substituted for the adhesive. Here, the authors describe the first effort in this program: adaptation of ASTM D950 (Impact strength of adhesive bonds). Basically, the authors installed ice-bonded test specimens in an Izod impact machine and measured the energy needed to debond the specimens. The main advantage of this test is its simplicity; many samples can be inexpensively prepared and tested. Its disadvantages include a restriction on specimen size and the generation of a nonuniform stress field. This paper describes the test procedures and results, and discusses their implications for standardized ice-adhesion testing.

MP 2885
MEASURING THE EFFECTIVENESS OF DEICING FLUIDS FOR REDUCING ICE ADHESION TO ROUGH SURFACES.
Lever, J.H., et al, International Conference on Offshore Mechanics and Arctic Engineering, 10th, Stavanger, Norway, June 23-28, 1991. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, W.A. Nixon, and D.S. Sodhi, New York, American Society of Mechanical Engineers, 1991, p.221-227, 15 refs.
Rand, J.H., McGilvary, W.R.
45-3173
ICE ADHESION, AIRCRAFT LANDING AREAS, ICE PREVENTION.
Through a series of laboratory tests, the effectiveness of eight different deicing fluids was examined for reducing ice adhesion to the rough, nonskid surfaces used on aircraft-landing areas of ships. The nonskid samples consisted of 46 x 46 cm coated steel plates having roughness peaks of 2-3 mm. On each sample, a light coating of deicer was first sprayed and then a uniform layer of freshwater glaze ice was accreted. The very rough, nonskid surfaces and the ice-deteriorating effect of deicing chemicals dictated a novel approach to measuring adhesion strength: the ice was loaded inertially by bouncing the iced samples off a stiff spring. The average shear adhesion strength was calculated by measuring the acceleration required to shed the ice. A relatively small amount of deicer (similar to 70 mL/sq m) applied in advance of ice accretion was found to be extremely effective in reducing ice adhesion to nonskid surfaces. Without deicer, cohesive failure occurs within the ice (at shearing stresses of about 2,000 kPa for the test temperature of -4 C), whereas all deicer-treated samples shed ice, on average, at 130 kPa or less. Furthermore, the best results (similar to 70 kPa) qualify the deiced nonskid surface as a practical, low-adhesion surface for freshwater ice accretions. Such results suggest that advance application of deicing chemicals would significantly assist ice removal from other rough surfaces (asphalt, concrete, etc.). The inertial-load apparatus developed here is well suited for ice adhesion studies of rough surfaces and yielded very low scatter for identically prepared samples. (Auth. mod.)

MP 2886
ICE SCAVENGING AND NUCLEATION: TWO MECHANISMS FOR INCORPORATION OF ALGAE INTO NEWLY-FORMING SEA ICE.
Ackley, S.F., *Eos. American Geophysical Union. Transactions,* Jan. 19, 1982, 63(3), p.54-55, Abstract only.
45-3409
ALGAE, CRYOBIOLOGY, SEA ICE, SCAVENGING, NUCLEATION, MARINE BIOLOGY.

MP 2887
ALGAL AND FORAM INCORPORATION INTO NEW SEA ICE.
Ackley, S.F., et al, *Eos. American Geophysical Union. Transactions,* Dec. 15, 1987, 68(50), p.1736, Abstract only.
Dieckmann, C., Shen, H.
45-3410
ALGAE, CRYOBIOLOGY, MARINE BIOLOGY, SEA ICE.

MP 2888
U.S. ARMY WHEELED VERSUS TRACKED VEHICLE MOBILITY PERFORMANCE TEST PROGRAM—REPORT 2: MOBILITY IN SHALLOW SNOW.
Green, C.E., et al, *U.S. Army Engineer Waterways Experiment Station. Geotechnical laboratory. Technical report,* May 1991, GL-91-7, 48p. + appends., 2 refs.
Blaisdell, G.L.
45-3446
SNOW VEHICLES, MODELS, TRACKED VEHICLES, PERFORMANCE, TRACTION, SNOW COVER EFFECT, MECHANICAL TESTS, MILITARY RESEARCH, MILITARY TRANSPORTATION, VELOCITY MEASUREMENT, TIRES, ACCURACY.
This study evaluates the mobility performance of four wheeled and five tracked vehicles. Mobility tests were conducted on snow by the US Army Engineer Waterways Experiment Station and the US Army Cold Regions Research and Engineering Laboratory (CRREL) at the Keweenaw Research Center near Houghton, MI, to determine traction (drawbar pull/motion resistance), slope negotiation, GO/NOGO, braking, and traverse negotiation. The vehicles were tested to develop fundamental mobility relations between vehicle characteristics and snow properties, validate specific snow relations in CRREL's snow mobility model, and modify the model as necessary to improve its prediction accuracy and adapt it for use in the NATO Reference Mobility Model, Army Mobility Model, and the Condensed Army Mobility Model System.

MP 2889
NONEVAPORATIVE PRECONCENTRATION TECHNIQUE FOR VOLATILE AND SEMIVOLATILE SOLUTES IN CERTAIN POLAR SOLVENTS.
Jenkins, T.F., et al, *Analytical chemistry,* July 1, 1991, 63(13), p.1341-1343, 11 refs.
Miyares, P.H.
45-3447
CHEMICAL ANALYSIS, SAMPLING, SOLUBILITY, LABORATORY TECHNIQUES, SALT WATER, SOIL ANALYSIS, SOIL POLLUTION, PHASE TRANSFORMATIONS.
In this paper, a simple nonevaporative preconcentration technique has been developed that is useful for miscible solvents that can be salted-out of aqueous solution. The procedure requires only the use of sodium chloride and deionized water, accurate volumetric measurements, and a magnetic stirrer. The method has been successfully demonstrated to preconcentrate both volatile and semivolatile organic solutes with a wide range of polarity. If a suitable solvent is used for extraction, this procedure gives the analyst an alternative to evaporative preconcentration. This has obvious implications for preconcentration of thermally labile compounds. If the preconcentrated extract is used in conjunction with purge-and-trap technology, at least an order of magnitude improvement in detection capability is possible. If the selected solvent is suitable for direct injection, analysts may be able to avoid the use of purge-and-trap technology for certain applications, thereby increasing throughput and decreasing analytical costs.

MP 2890
RECENT PROGRESS IN SNOW AND ICE RESEARCH.
Richter-Menge, J.A., et al, *Reviews of geophysics. Supplement,* Apr. 1991, p.218-226, Refs. p.222-226.
Colbeck, S.C., Jezek, K.C.
45-3451
ICE SHEETS, ICE MECHANICS, SNOW COVER, RESEARCH PROJECTS, BIBLIOGRAPHIES.
Snow and ice research during the past quadrennial covers a wide range of topics varying from the climatic effects of large ice sheets and sea ice covers to applied problems such as the icing of power lines and communication facilities. This review focuses in more detail on three topics of the many subjects investigated to provide a more coherent look at the advances achieved and prospects for the future. These are: the influences of layers in seasonal snow covers; research in ice mechanics on freshwater and sea ice; and remote sensing of polar ice sheets. These topics provide useful examples of the general needs in snow and ice research applicable to most areas, e.g. better representation in models of detailed processes, carefully controlled laboratory experiments to quantify processes, and field studies to provide the appropriate context for interpretation of processes from remote sensing.

MP 2891
TEST METHODS TO CHARACTERIZE LOW TEMPERATURE CRACKING.
Janoo, V.C., et al, Workshop on Paving in Cold Areas, 4th, Sapporo, Japan, Sep. 4-6, 1990. Proceedings. Vol.1, Tsukuba, Japan, Ministry of Construction, Public Works Research Institute, 1990, p.257-287, 52 refs.
Vinson, T.S., Haas, R., Bayer, J., Jr.
45-3500
PAVEMENTS, CRACKING (FRACTURING), THERMAL STRESSES, COLD STRESS, ANALYSIS (MATHEMATICS), TENSILE PROPERTIES, STRAIN TESTS.
Thermal cracking of asphalt concrete pavements is a serious problem in the northern tier states of the coterminous U.S. and in Alaska, Canada, Japan and parts of Europe. One theory on the cause of thermal cracking is that the thermally induced tensile stress in the asphalt concrete exceeds its tensile strength. Cracks that result from this condition are called low temperature cracks. Another theory is that thermal cracks occur when the pavement structure is thermally fatigued by daily temperature cycles. As part of a cooperative study by CRREL and U.S. Strategic Highway Research Program A003, a research project was established to investigate thermal cracking. Prior to starting the project, a literature review was conducted on current test methods for characterizing asphalt concrete behavior at low temperatures and/or under thermal cycling. The objective of the survey was to determine the types of tests and equipment currently used, the properties measured by the respective tests, and the degree to which the tests simulate actual field conditions. The purpose of this paper is to present the results of this review.

MP 2892
NATURAL CONVECTION IN THE SUBARCTIC SNOW COVER.
Sturm, M., et al, *Journal of geophysical research,* July 10, 1991, 96(B7), p.11,657-11,671, 58 refs.
Johnson, J.B.
45-3463
SNOW COVER, SNOW PERMEABILITY, AIR FLOW, CONVECTION, SNOW TEMPERATURE, TEMPERATURE MEASUREMENT, SOIL TEMPERATURE, METAMORPHISM (SNOW), MASS TRANSFER, SNOW AIR INTERFACE.
The purpose of this study was to determine if air convects in a natural snow cover. To detect convection, the temperature field in the subarctic snow cover in Fairbanks, AK, was measured hourly during three winters using thermistors which were suspended on threads and allowed to be buried by snowfall. The results indicate that convection occurred both sporadically in 1984-1985 and almost continuously in 1985-1986 and 1986-1987. The evidence was (1) simultaneous warming and cooling at different locations in a horizontal plane in the snow, and (2) horizontal temperature gradients of up to 16 C/m. During the winter, warm and cold zones developed in the snow and remained relatively fixed in space. These zones appear to be the result of a diffuse plumelike convection pattern linked to spatial variations in the temperature of the snow-soil interface. Air flow was inferred to have been primarily horizontal near the base of the snow and vertical elsewhere. The convective circulation was time-dependent, with perturbations such as high wind or rapid changes in air temperature triggering periods when horizontal temperature gradients were strongest, suggesting that these were also periods when the air flow was fastest. The coincidence of depth hoar crystals with horizontal *c* axes and the horizontal flow lines at the base of the snow suggests that convection may have affected crystal growth directions.

MP 2893
WHITE PHOSPHOROUS LINKED AS CAUSE OF WATERFOWL DEATHS AT ALASKAN FIRING RANGE. *Environmental update,* July 1991, p.5.
45-3455
POLLUTION, ENVIRONMENTAL IMPACT, WETLANDS, MILITARY FACILITIES, ANIMALS.

MP 2894
FRACTURE AND BREAKUP OF RIVER ICE COVER: DISCUSSION AND REPLY.
Demuth, M.N., et al, *Canadian journal of civil engineering,* Apr. 1991, 18(2), p.336-339, 13 refs. For article being discussed see 44-3702.
Prowse, T.D., Beltaos, S., Daly, S.F.
45-3537
RIVER ICE, ICE JAMS, ICE BREAKUP, ICE COVER STRENGTH, ICE MECHANICS, ICE BREAKING, FLEXURAL STRENGTH.

MP 2895
ARCTIC RESEARCH OF THE UNITED STATES, VOL.5.
U.S. Interagency Arctic Research Policy Commission, Washington, D.C., Spring 1991, 99p., 35 refs.
Brown, J., ed, Bowen, S., ed, Cate, D.W., ed, Valliere, D.R., ed.
45-3544
RESEARCH PROJECTS, LEGISLATION, ORGANIZATIONS, COST ANALYSIS, MEETINGS, INTERNATIONAL COOPERATION.

MP 2896
TWENTY YEARS OF ICE SYMPOSIA.
Frankenstein, G.E., IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.1. [1990], p.43-65.
45-3564
ICE, MEETINGS, HISTORY.

MP 2897
PREDICTION OF RESERVOIR FREEZEOVER.
Ashton, G.D., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.1, [1990], p.124-135, 8 refs.
Mulherin, N.D.
45-3570
RESERVOIRS, FREEZEUP, SIMULATION, WATER TEMPERATURE.
One of the critical gaps that persists in reservoir water temperature and quality modeling is in the ability to know the temperature of the water at the time of freezeover. Prior to and after freezeover, existing simulation models are capable of following the temperature structure reasonably well, but the "after" simulation requires starting values or the time of initial ice cover formation. The few existing year-round simulation models either impose the ice cover when the 0 C surface temperature is reached or use a heuristic set of threshold criteria proposed by Ashton. The latter has not been well tested and the former is known to fail at times, particularly when wind prevents formation of a stable ice cover. The authors set out to determine what conditions of wind, water temperature, and air temperature lead to the freezeover recorded at the mainstem dams of the Missouri River. The authors tested the criteria proposed by Ashton, a modified version of those criteria, and an index approach where the daily index is a combination of air temperatures, release water temperatures, and wind speeds. The limitations of an index approach are discussed, including the irregular behavior of freezeover and the conceptual difficulty of assessing how the ice cover gains sufficient integrity to withstand forces of wind and current during its formative stages.

MP 2898
EXPERIMENTAL OBSERVATIONS OF SHOVING AND THICKENING: COMPARISON TO EQUILIBRIUM THICKNESS THEORY.
Zufelt, J.E., IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.1, [1990], p.500-510, 6 refs.
45-3602
ICE COVER THICKNESS, ICE MECHANICS, ICE WATER INTERFACE, ICE MODELS.
While several models have been developed over the past 25 years to simulate ice cover progression and the shoving and thickening process, it remains as one of the least understood topics in ice hydraulics. Most models are based on some adaptation of equilibrium ice thickness theory, and treat ice shoving and thickening as a steady or quasi-steady process. During ice shoving, the water and ice flows are highly unsteady. Discharge is constantly changing as a result of ice transport and deposition under the cover. The interaction between the flows of ice and water is very complex, and except at the ice surface, it is almost impossible to observe in nature. As a first step to improve the understanding of shoving and thickening, several series of experiments were conducted to observe and document the process. The experiments were conducted in laboratory flumes using real and plastic ice. Stable brash ice accumulations were formed in the flume, and the discharge was then varied to induce shoving and thickening. Hydraulic and ice data were gathered, including velocity, ice thickness, and jam length. These observations are presented, and the data are compared to results from equilibrium-based models. Differences between the experimental and theoretical results are identified, and explanations for these differences are given.

MP 2899
LABORATORY INVESTIGATION OF TRASH RACK HEATING TO PREVENT FREEZEUP BY FRAZIL ICE.
Daly, S.F., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.2, [1990], p.584-595, 12 refs.
Haynes, F.D., Garfield, D., Gagnon, J.J.
45-3609
WATER INTAKES, HYDRAULIC STRUCTURES, CHANNELS (WATERWAYS), FREEZEUP, FRAZIL ICE, ELECTRIC HEATING, ICE CONTROL, DESIGN, COLD WEATHER TESTS.
There have been no systematic studies of heated trash racks under frazil ice conditions, so a heated, model intake trash

rack was observed in the refrigerated flume facility at USACRREL, Hanover, NH. Supercooled water and frazil ice were generated in this facility and allowed to pass through the model trash rack. In each test a near constant upstream head was maintained and the discharge through the trash rack was allowed to vary. A novel and efficient means of applying heat is described. The heat transfer rate from the rack was measured and is described in terms of nondimensional parameters. The discharge rates through the rack as a function of time and heat application rate are described. Based on these observations, an approach to quantify the design of heated trash racks is proposed.

MP 2900
MODEL SURFACE TREATMENT FOR TESTING IN ICE.
Tatinclaux, J.C., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.2, [1990], p.766-775, 6 refs.
Martinson, C.
45-3627
METAL ICE FRICTION, EXPERIMENTATION, COATINGS, MODELS, SURFACE PROPERTIES, SHIPS, SIMULATION, ICE SOLID INTERFACE.
Forces due to ice friction may represent a significant portion of the total forces exerted on a floating or grounded structure subjected to ice action. In model tests, one of the parameters that must be specified is the kinetic friction factor, f(i), between the model ice and the surface of the model structure. This paper describes a method of surface treatment of a model structure with an appropriate mixture of silica powder and paint which allows a prescribed friction factor to be achieved. This surface treatment method has the advantage of eliminating previous trial-and-errors that were often very time consuming. Other methods of surface treatment for the same purpose of obtaining a given ice kinetic friction factor are known to exist but are often proprietary and have not been published in the open literature.

MP 2901
PREDICTION OF THE HORIZONTAL PROGRESSIONS OF ARCTIC ICE BY REMOTE METHODS.
Frankenstein, S., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.2, [1990], p.1113-1121, 10 refs.
Frankenstein, G.
45-3658
SEA ICE DISTRIBUTION, ICE CONDITIONS, ICE FORECASTING, SPACEBORNE PHOTOGRAPHY, AIR ICE WATER INTERACTION, ICE GROWTH, RADIOMETRY, OCEAN CURRENTS, WATER TEMPERATURE, SALINITY.
Satellites are a tool with which seasonal ice conditions in the Arctic Ocean may be studied. During the fall, when new ice growth is at a maximum, it is necessary to make observations at wavelengths at which atmospheric water vapor is transparent, due to the presence of high cloud concentrations during these months. The scanning multichannel microwave radiometer, and the upcoming SAR are passive response satellites that operate at frequencies which will make it possible to distinguish open water from first-year and multiyear ice. To break these signals down into frazil/new ice and other categories, it is necessary to combine the satellite observations with heat flux calculations. To do this, weather data for the area of interest are needed, which are available globally on a nearly real-time basis. The only other information needed to approximate the heat flux is the water or ice surface temperature. If no such data exist, a reasonable estimate of the water temperature can be obtained from published monthly sea-surface charts, and surface ice temperatures determined from equations developed from studies on the relationships between air/water temperatures and the concurrent ice thickness. Combining the satellite data and the resulting heat flux calculations into a model, it is thus possible to follow the growth of first-year ice into the open water in a given area. With the advent of the SAR satellite, these estimates can be done in real time, thus providing an important tool for analyzing offshore operations in the arctic shelf seas.

MP 2902
REPORT OF WORKING GROUP ON ICE MODELLING MATERIALS.
Timco, G.W., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.3. [1990], p.81-98.
Tatinclaux, J.C.
45-3668
ICE MECHANICS, ICE MODELS.

MP 2903
WINTER HABITATS OF ATLANTIC SALMON AND BROOK TROUT IN SMALL ICE-COVERED STREAMS.
Calkins, D.J., IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.3, [1990], p.113-126, 34 refs.
45-3670
ECOLOGY, CRYOBIOLOGY, RIVER ICE, ANIMALS, COLD WEATHER SURVIVAL, ICE COVER EFFECT.
A review of winter habitat studies conducted in ice-covered streams for two species of salmonids (Atlantic salmon and brook trout) provided some general information on substrate conditions, flow velocities and depths. Brook trout fry are usually found at depths of less than 40 cm and at focal velocities of 5 cm/s or less; juveniles of the same species are found at velocities of less than 17 cm/s but at slightly greater depths. Atlantic salmon young-of-the-year and parr (age 1) were found in the one study to be in the substrate and the velocities at the 0.6 depth in 40-45 cm of water were 40-45 cm/s. The size of substrate used by all salmonids is a function of fish size, with both species preferring a combination of sand, gravel and rubble. Silt in high concentrations is detrimental to sustaining a natural fish population. A lack of continuous physical, chemical and biological measurements throughout the ice-covered season was a common deficiency of the studies reviewed, indicating a need for more interdisciplinary work.

MP 2904
ON THE MOTION OF RIVER ICE NEAR A BREAKING FRONT.
Ferrick, M.G., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.3, [1990], p.201-213, 4 refs.
Weyrick, P.B.
45-3677
RIVER FLOW, ICE BREAKUP, RIVER ICE, ANALYSIS (MATHEMATICS), ICE MECHANICS.
A time series of ice velocity data was obtained from videotape of the initial 300 s of motion at a point during a controlled dynamic ice breakup of the Connecticut River. A polynomial fit to the data provides a smooth velocity-time relationship that eliminates the noise in the data, and identifies the primary ice motion. The hydraulic radius associated with the ice cover changes continuously with the ice velocity. The authors expand the analysis by assuming a constant breaking front speed and consistent ice velocity behavior through a reach local to the measurement site. The results obtained include the total ice acceleration, the equilibrium ice velocity as a function of bank stress, the time-varying bank resistance at the measurement location, the convergence behavior of the moving ice sheet and the influence of breaking front speed on this behavior, and the ice continuity implications of these results at the breaking front.

MP 2905
FREQUENCY OF INTERMITTENT ICE CRUSHING DURING INDENTATION TESTS.
Sodhi, D.S., et al, IAHR Symposium on Ice, 10th, Espoo, Finland, Aug. 20-23, 1990. Proceedings, Vol.3, [1990], p.277-289, 13 refs.
Nakazawa, N.
45-3682
ICE PRESSURE, ICE LOADS, PENETRATION TESTS, ICE SOLID INTERFACE, ICE STRENGTH.
The results of small-scale indentation tests with freshwater ice are analyzed to obtain the frequency of intermittent crushing failure. From the experimental results, a correlation is obtained between the average distance travelled by an indenter during successive failure events and the maximum relative displacement of the indenter with respect to the carriage during the loading phase of a cycle. From this correlation, the frequency of intermittent crushing can be obtained in terms of structural stiffness, ice velocity, effective pressure, indenter width, and the ice thickness.

MP 2906
PREDICTING PAVEMENT RESPONSE DURING THAW WEAKENING PERIODS USING THE FALLING WEIGHT DEFLECTOMETER.
Janoo, V.C., et al, International Conference on Bearing Capacity of Roads and Airfields, 3rd, Trondheim, Norway, July 3-5, 1990. Proceedings, Vol.1. Edited by R.S. Nordal et al, Trondheim, Norway, Norwegian Institute of Technology, 1990, p.31-40, 14 refs.
Berg, R.L.
45-3689
PAVEMENTS, MEASUREMENT, FREEZE THAW TESTS, THAW WEAKENING, THAW DEPTH, SUBGRADE SOILS, MECHANICAL TESTS, SOIL MECHANICS, BEARING STRENGTH.
Pavement structures in northern regions are subjected to seasonal temperature changes. It is important for pavement engineers to have a tool for determining the structural capacity of a pavement during thaw weakening periods. Tests were conducted at the U.S. Army Cold Regions Research and Engineering Laboratory to study the performance of pavement structures during thaw periods. During the thaw period, temperature and deflection measurements were obtained. The results of the deflection measurements are presented in this paper. A method is also presented for estimating the thaw depth using frequent falling weight deflectometer measurements.

MP 2907
EXPERIMENTAL COMPARISON OF EPA AND USATHAMA DETECTION AND QUANTITATION CAPABILITY ESTIMATORS.
Grant, C.L., et al, *American laboratory,* Feb. 1991, p.15-33, 18 refs.
Hewitt, A.D., Jenkins, T.F.
45-3735
WASTES, POLLUTION, CHEMICAL ANALYSIS, DETECTION, STATISTICAL ANALYSIS.

MP 2908
GEOTEXTILES AS CAPILLARY BARRIERS.
Henry, K.S., *Geotechnical fabrics report,* Mar.-Apr. 1990, p.30-36, 12 refs.
45-3736
GEOTEXTILES, CAPILLARITY, THERMAL INSULATION, SOIL FREEZING, FROST HEAVE, FROST PROTECTION, SOIL STABILIZATION.

MP 2909
EFFECT OF GEOTEXTILES ON WATER MIGRATION IN FREEZING SOILS AND THE INFLUENCE OF FREEZING ON PERFORMANCE.
Henry, K.S., Geosynthetics '91 Conference, 1991, p.469-483, 10 refs.
45-3737
GEOTEXTILES, SOIL FREEZING, SOIL WATER MIGRATION, THERMAL INSULATION, CAPILLARITY, FROST PROTECTION, SOIL STABILIZATION, FROST HEAVE.
It is believed that certain geotextiles can be used in place of granular capillary breaks to reduce frost heave because they have relatively large pore sizes and their fibers tend to repel water. An experimental program was conducted to verify that geotextiles reduce frost heave by inhibiting water flow to the freezing front, and to examine the performance of soil-geotextile samples when subjected to more than one freeze-thaw cycle. The addition of a needle-punched fabric reduced frost heave rate in the test soil by an average of 65%, while a heat-bonded fabric reduced frost heave by 37%. The presence of needle-punched fabric resulted in very high soil moisture tensions and soil pressure gradients above the fabric during freezing. Both of these conditions would decrease water flow rates to the portion of the soil which is freezing. Results of tests in which a soil/fabric system was subjected to three freeze/thaw cycles indicate little, if any, influence on the fabric's ability to reduce frost heave. Estimates of unsaturated hydraulic conductivities were made by using Darcy's law in conjunction with measured soil pressure gradients in the soil and assumed water flow rates based on the rate of frost heave. The results of this procedure suggest that there is a relationship between soil moisture tension and hydraulic conductivity in the frozen fringe and conditions in the unsaturated soil below the freezing front.

MP 2910
PILOT SCALE STUDIES OF SLUDGE DEWATERING IN A FREEZING BED.
Martel, C.J., et al, National Conference on Environmental Engineering, Hamilton, Ontario, May 15-18, 1990. Proceedings, Canadian Society for Civil Engineering, [1990], 15p., 8 refs.
Diener, C.J.
45-3738
SLUDGES, ARTIFICIAL FREEZING, WATER TREATMENT, SEWAGE TREATMENT, FREEZE DRYING, FREEZE THAW CYCLES.
In 1986, a pilot scale sludge freezing bed was constructed at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH, USA. This bed was operated for the next three years using both anaerobically and aerobically digested sludges. Results indicate that both sludges were effectively dewatered by this process. The final solid contents were 39.3% and 24.5% for anaerobically digested and aerobically digested sludges respectively. The quality of the meltwater from the bed was similar to that of raw wastewater. The actual depth of sludge frozen and thawed in the bed during each year of operation was very close to that predicted by design models. The maximum depth of sludge frozen during this study was 1.14 m. Operational experience demonstrated the importance of a sand layer at the bottom of the bed for adequate drainage. Also, odors developed when the meltwater was allowed to accumulate in the bed. Odors were not a problem when the meltwater was drained away as quickly as it formed. All sludges were easily removed with a front end loader.

MP 2911
PHASE CHANGE HEAT TRANSFER ANALYSIS WITH APPLICATIONS TO FROST SHIELDING.
Farag, I.H., et al, International Heat Transfer Conference, 9th, Jerusalem, Aug. 19-24, 1990. Proceedings, Vol.3. Heat transfer 1990, Washington, D.C., Hemisphere Publishing Corporation, [1990], p.9-13, 19 refs. For another version see 45-2915.
Virameteekul, N., Phetteplace, G.E.
45-3739
PHASE TRANSFORMATIONS, HEAT TRANSFER, THERMAL INSULATION, FROST PROTECTION, MATHEMATICAL MODELS, UNDERGROUND PIPELINES.
A computer package has been developed to solve heat transfer problems with phase change and to predict the temperature distribution and phase front location variation with time. The fixed-mesh package incorporates latent heat effects. The time domain solution uses a central difference procedure. Underground freezing of pipelines with and without frost shields is studied using this package, and the results are discussed.

MP 2912
SOLVENT-WATER PARTITIONING AND EXTRACTION OF PHOSPHONATES.
Leggett, D.C., *U.S. Army Chemical Research Development and Engineering Center. Special publication,* Aug. 1990, CRDEC-SP-024, p.889-895, 18 refs. Included in the proceedings of the Scientific Conference on Chemical Defense Research, Nov. 14-17, 1989.
45-3740
POLLUTION, WASTE TREATMENT, MILITARY RESEARCH, CHEMICAL PROPERTIES, WATER CHEMISTRY, SOIL CHEMISTRY, SOLUTIONS.
Phosphonates are used as G-agent simulants in a number of applications. Partitioning of dimethyl methylphosphonate (DMMP) between water and various solvents was examined with a view toward optimization of solvent extraction methods for this class of compounds. The results of these partitioning experiments indicate that the best solvents for extraction of DMMP from water are H-donors, suggesting H-bonding as the principal mechanism. Advantage was also taken of the universal salting-out effect; saturating the aqueous phase with NaCl increased the partition coefficient of DMMP six-fold (0.78 log units), irrespective of the solvent. By analogy, similar results may be expected for other low molecular weight phosphonates, phosphites, phosphates and phosphonofluoridates.

MP 2913
SIMULANT INTERACTION WITH ICE AND AGENT PERSISTENCE ESTIMATION FOR COLD REGIONS.
Leggett, D.C., *U.S. Army Chemical Research Development and Engineering Center. Special publication,* Dec. 1988, CRDEC-SP-002, p.237-247, 22 refs. Included in the proceedings of the 2nd International Simulant Workshop.
45-3741
POLLUTION, IMPURITIES, CHEMICAL PROPERTIES, MILITARY RESEARCH, SOLUBILITY, ICE COMPOSITION, SIMULATION.
The role of ice surfaces in determining G-agent persistence in cold regions is examined. A solubility model is used with available data to predict the weathering of agents on snow due to evaporation and hydrolysis. The results compare well with experiment, but the model cannot be validated for other agents without more information. The data most critically needed are the solubility of water (ice) in agents and their unbuffered hydrolysis rates in water.

MP 2914
LONGITUDINAL DISPERSION IN OVERLAND FLOW OF WASTEWATER.
Adrian, D.D., et al, Cambridge, Massachusetts Institute of Technology, [1990], p.1-8, 3 refs. For presentation at the International Conference on Physical Modeling of Transport and Dispersion, Aug. 7-10, 1990.
Martel, C.J.
45-3742
SEWAGE TREATMENT, WATER TREATMENT, WASTE TREATMENT, WATER FLOW, FLOW RATE, VEGETATION FACTORS, SLOPES.
A series of experiments were conducted to measure dispersion in an overland flow system. The overland flow system consisted of three parallel grass covered areas 30.5 m long and 2.9 m wide, and sloping at 5%. Primary wastewater was applied at the upper end of the slopes and was collected at the lower end of the slope. Steady hydraulic flow was established prior to an area source of chloride tracer being applied to the upstream end of the slope. The chloride tracer concentration was measured at the outlet of the overland flow system. Data were collected during three consecutive years so that the effects of grass growth and slope maturation on dispersion could be studied. The average velocities during the dispersion measurements varied from .003 m/s to .025 m/s. Longitudinal dispersion coefficients varied from a low of .02 sq m/s to a high of 0.3 sq m/s. Phenomena which led to difficulties in relating the dispersion measurements to velocity include the continual changing growth patterns of the grass, grass harvesting patterns, and the development of erosion channels on the slope.

MP 2915
MEASUREMENT OF HEAT LOSSES FROM A BURIED HEAT DISTRIBUTION SYSTEM.
Phetteplace, G.E., Heat transfer in geophysical media, New York, American Society of Mechanical Engineers, 1991, p.47-54, 11 refs. Presented at the 28th National Heat Transfer Conference, Minneapolis, MN, July 28-31, 1991. HTD (Heat Transfer Division), Vol.172.
45-3743
HEATING, HEAT PIPES, HEAT LOSS, HEAT TRANSFER, BUILDINGS, MILITARY FACILITIES.
The actual heat losses from operating heat distribution systems used to convey heat from central plants to buildings are not well known. The effect of the type of distribution system and the length of time in service on heat losses are also not known. Methods used to calculate heat losses have not been adequately verified. This paper will describe a field project at Ft. Jackson, SC, which addresses these needs. At Ft. Jackson three different types of systems have been instrumented: shallow concrete trench, steel conduit with supply and return in common conduit, and separate conduits for supply and return pipes. The heat losses from these systems have been and are being monitored using several methods. Data have been collected from these sites for over four years. The initial results will be presented in this paper.

MP 2916
DISSOLUTION OF METALS FROM SOILS AND SEDIMENTS WITH A MICROWAVE-NITRIC ACID DIGESTION TECHNIQUE.
Hewitt, A.D., et al, *Atomic spectroscopy,* Sep.-Oct. 1990, 11(5), p.187-192, 26 refs.
Reynolds, C.M.
45-3744
SOIL POLLUTION, WASTE TREATMENT, MICROWAVES, SOIL CHEMISTRY, METALS.
A microwave-nitric acid digestion technique for metal extraction efficiency using an environmental reference standard sediment has been tested. Recoveries have been compared with a certified hot-plate digestion method for a standard soil. The microwave-heated acid extraction of metals from soils and sediments is faster, more routine, and less subject to technician error; yet, it does not sacrifice extraction efficiency or precision. The proposed procedure appears to be suitable for extracting Ag, As, Ba, Cd, Cu, Cr, Hg, Ni, Pb, Se, Tl, and Zn from anthropogenically contaminated soils and sediments.

MP 2917
COMPARATIVE STUDY OF ICING RATES IN THE WHITE MOUNTAINS OF NEW HAMPSHIRE.
Govoni, J.W., International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-31, 1990. Proceedings, [1990], 5p., 6 refs.
45-3745
ICE ACCRETION, ICING RATE, TOPOGRAPHIC EFFECTS, METEOROLOGICAL FACTORS, MOUNTAINS, POWER LINE SUPPORTS.
During the three winter icing seasons from 1987-1990, meteorological data including wind speed and direction, air temperature and icing rates were measured at two mountain sites. These sites, located in the White Mountains of New Hampshire, were the summit of Cannon Mountain and a location on the west side of Mt. Washington (Cog), both at an elevation of 1230 m. This study compared icing rates and intensities from a site located at the summit of a mountain to those of a site of similar elevation located on the weather-prevalent side of a mountain. Analysis of data from the same weather system passages for both sites show a substantially higher icing rate at the mountain summit site than at the mountainside site.

MP 2918
EFFICIENCY ANALYSIS OF A STEAM HEAT DISTRIBUTION SYSTEM.
Phetteplace, G.E., International Symposium on Fluids for District Heating, Copenhagen, Apr. 10-11, 1991. Proceedings, Technical University of Denmark, 1991, p.199-213, 9 refs.
45-3746
HEATING, HEAT PIPES, COST ANALYSIS, STEAM, ANALYSIS (MATHEMATICS), BUILDINGS, MILITARY FACILITIES, HEAT TRANSFER.
This paper describes an efficiency analysis for the steam heat distribution system at Hawthorne AAP. The analysis is based on the limited data available from the boiler logs maintained at the central plant. From this information, along with energy and mass balances that are constructed for the central plant data, gross measures of efficiency are obtained. A weighted average of the heating degree days for two groups of buildings connected to the system is developed as an indicator of the load on the system. Statistical analysis is used with the data from a 181-day continuous period of boiler operation to obtain estimated linear functions for the efficiency measures as they relate to the heating load. The results of the analysis show that only 43.5% of the steam input to the distribution system is used to meet the required space heating load. The results also indicate that on the average only 46.2% of the steam that leaves the plant returns as condensate. By converting to a low temperature hot water heat distribution system it is estimated that savings would exceed $292,000 for the 181-day study period.

MP 2919
THAW WEAKENING OF PAVEMENT STRUCTURES IN SEASONAL FROST AREAS.
Janoo, V.C., et al, *Transportation research record,* 1990, No.1286, p.217-233, 16 refs.
Berg, R.L.
45-3747
THAW WEAKENING, PAVEMENTS, FREEZE THAW TESTS, SEASONAL FREEZE THAW, THAW DEPTH.
Pavement structures in the northern United States, Canada, Scandinavia, and other seasonal frost areas of the world are subject to freezing in winter and thawing in spring. Most damage to pavements in seasonal frost areas occurs during the spring thaw and, to a lesser extent, during partial thaw periods in winter. To minimize damage, pavement engineers must be able to determine the structural capacity of road and airfield pavements during thawing periods. Four pavement test sections were built in the Frost Effects Research Facility at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH, to study the performance of various pavement structures subjected to freeze-thaw cycling. The test sections consisted of asphalt concrete pavement over a clay subgrade, asphalt concrete over 178 mm of crushed gravel and 203 mm of clean sand on a clay subgrade, and asphalt concrete over 254 mm of crushed gravel and 127 mm of clean sand on a clay subgrade. Thermocouples were embedded throughout the pavement structure and subgrade, and the pavement structure was subjected to several freeze-thaw cycles. Deflection measurements taken during the thawing periods at four locations in each test section used a Dynatest falling-weight deflectometer (FWD) to validate existing back-calculation procedures for pavements subject to seasonal frost. Soon it became apparent that the back-calculation procedures had difficulties. Another study was initiated to determine if additional information pertaining to freeze-thaw cycling could be obtained from the FWD measurements. The results of the second study are presented.

MP 2920
PREDICTION OF DAMAGE TO FLEXIBLE PAVEMENTS IN SEASONAL FROST AREAS.
Allen, W.L., et al, *Transportation research record,* 1990, No.1286, p.234-247, 16 refs.
Berg, R.L., Bigl, S.R.
45-3748
PAVEMENTS, FROST RESISTANCE, FROST ACTION, SEASONAL FREEZE THAW, COMPUTER PROGRAMS, FATIGUE (MATERIALS), THAW WEAKENING.
The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) is developing a mechanistic pavement design method for use in seasonal frost areas by the Corps of Engineers and the Air Force. The mechanistic method will employ results from a series of five computer programs that compute soil and pavement moisture and temperature conditions (FROST1), resilient modulus and Poisson's ratio (TRANSFORM), stresses and strains in the pavement system (JULEA and NELAPAV), and cumulative damage (CUMDAM). The model has been calibrated for the properties of six soils. Five fatigue equations, three based on horizontal strain at the bottom of the asphalt layer and two based on vertical strain at the top of the subgrade, are used to determine the cumulative damage for two-, three-, and four-layer pavement sections at Springfield, MO, and Rochester, MN. Although all of the equations predicted failure during the design life for each pavement section modeled, significant jumps occurred during the spring, indicating that the thaw period is crucial in the fatigue life of a pavement.

MP 2921
RIVER AND LAKE ICE CONDITIONS AS DETERMINED FROM AIRSAR IMAGERY.
Melloh, R.A., et al, *California Institute of Technology. Jet Propulsion Laboratory. JPL publication,* Nov. 15, 1990, No.90-56, p.37-42, 5 refs.
Gatto, L.W.
45-3755
ICE CONDITIONS, RIVER ICE, LAKE ICE, SYNTHETIC APERTURE RADAR, REMOTE SENSING, AIRBORNE RADAR.
Synthetic aperture radar (SAR) imagery data can provide information on types and distribution of river and lake ice needed for studying river ice processes and dynamics, monitoring ice during winter navigation, and formulating ice control strategies. Visible and IR remote sensing systems cannot provide such data, and present field methods are inadequate for characterizing ice conditions over long river reaches. The ongoing analysis of JPL's AIRSAR imagery data and concurrent ground truth of ice conditions on the Tanana River and surrounding lakes near Fairbanks, AK, in Mar. 1988, has resulted in several findings: hummocked ice covers and zones of variable ice surface roughness within them can be differentiated; C- and L-band data are more sensitive than P-band to the range of surface roughnesses encountered;

smooth, level ice that is clear or contains small bubbles produces little backscatter; snow-covered river ice, whether rough or smooth, is distinguishable from snow-covered river sediments on exposed river beds and unvegetated bars; and open water leads are readily distinguished.

MP 2922
ABSORPTION COEFFICIENTS OF ICE FROM 250 TO 400 NM.
Perovich, D.K., et al, *Geophysical research letters,* July 1991, 18(7), p.1233-1235, 14 refs.
Govoni, J.W.
45-3761
ICE COVER, ICE OPTICS, LABORATORY TECHNIQUES, REMOTE SENSING.
Absorption coefficients for pure bubble-free ice are a critical element in theoretical efforts to determine levels of ultraviolet radiation reaching marine biota in and under a sea ice cover. A 3-m block of ice was used to measure these coefficients from 250 to 400 nm. Absorption coefficients were found to increase from 0.092/m at 400 nm to 0.665/m at 250 nm. Values in the ultraviolet were shown to be comparable to visible results from 580 to 720 nm. This suggests that existing data on the interaction of visible light with snow and sea ice can be used as a first-order estimate of ultraviolet optical properties. (Auth.)

MP 2923
INTERPRETATION OF SYNTHETIC APERTURE RADAR IMAGERY OF SNOW-COVERED RIVER ICE.
Melloh, R.A., et al, U.S. Army Corps of Engineers Remote Sensing Symposium, 7th, Portland, OR, May 7-9, 1990. Proceedings, 1990, 13p., 9 refs.
Gatto, L.W.
45-3766
SYNTHETIC APERTURE RADAR, RADAR PHOTOGRAPHY, RIVER ICE, ICE CONDITIONS, REMOTE SENSING, ICE SURVEYS, SNOW COVER EFFECT, PHOTOINTERPRETATION.
An ongoing CRREL research project is interpreting snow and ice conditions on the Tanana River near Fairbanks, AK, using airborne synthetic aperture radar (AIRSAR) imagery. The data in this report were acquired in Mar. 1988 by NASA and the Jet Propulsion Laboratory. The C-, L- and P-band images include four polarizations (HH, VV, HV and VH) and represent both wet and dry snow conditions. Ground truth data taken during the SAR overflights include snow and ice depth, stratigraphy, and surface roughness, as well as aerial video and impulse radar traces. Results to date confirm that the radar distinguishes accumulation ice covers (ice jams), smooth ice, open leads, and exposed river beds and bars. Variation in the magnitude of radar backscatter is observed along ice jams and is dependent on radar wavelength and ice jam roughness. The ability to distinguish river ice types and conditions on the images indicates good potential for the use of the data in studies of river ice processes and in engineering applications.

MP 2924
MICROWAVE-HEATED-ACID DISSOLUTION OF METALS FROM CONTAMINATED SOILS AND SEDIMENTS.
Hewitt, A.D., et al, *U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). Report,* 1989, CETHA-TE-TR-90055, p.463-470, 19 refs. Proceedings of the 14th Annual Army Environmental R&D Symposium, Williamsburg, VA, Nov. 14-16, 1989.
Reynolds, C.M.
45-3765
SOIL POLLUTION, WASTES, CHEMICAL ANALYSIS, SOIL CHEMISTRY, METALS.

MP 2925
AMMONIUM UPTAKE BY FIELD-GROWN *ERIOPHORUM VAGINATUM* ROOTS UNDER LABORATORY AND SIMULATED FIELD CONDITIONS.
Marion, G.M., et al, *Holarctic ecology,* Feb. 1990, 13(1), p.50-55, 34 refs.
Kummerow, J.
45-3767
TUNDRA, NUTRIENT CYCLE, PLANT ECOLOGY, PLANT PHYSIOLOGY, ROOTS, ECOSYSTEMS.
Nitrogen (N) deficiencies in tundra ecosystems could be caused, in part, by the kinetics of root N uptake. The objectives of this study were to quantify NH4 uptake by field-grown excised roots of *Eriophorum vaginatum* I. under controlled NH4 concentrations (0-250 micromoles/l) and temperatures (5-20 C) and to evaluate this laboratory derived model as a means of estimating field NH4 uptake. There was no consistent temperature effect on root NH4 uptake, which suggests a relative insensitivity of *E. vaginatum* roots to short-term temperature fluctuations. The Michaelis-Menten equation parameters for NH4 uptake were Vmax=22.1 micromoles/h/g and Km=191 micromoles/l. Using field NH4 concentrations, field *E. vaginatum* root biomass data, and the Michaelis-Menten equation, an estimate was made of NH4 uptake over a 42 day period. This estimate of NH4 uptake accounted for 28% of the net incorporation of N into leaves and roots, which is a reasonable estimate for *E. vaginatum* which relies primarily on N retranslocation for supplying new leaves and roots. Major uncertainties in field N uptake rates, model parameterization, and site characterization preclude an accurate model validation and indicate research areas most in need of future study.

MP 2926
MAXIMUM VARIATION OF AIR/SNOW INTERFACE TEMPERATURE.
Bates, R.E., et al, *U.S. Army Chemical Research, Development and Engineering Center. Report,* Nov. 1990, CRDEC-CR-092, p.411-422, 14 refs. Proceedings of the 14th Smoke/Obscurants Symposium, Vol.2.
Yen, Y.C., Gerard, S.
45-3768
SNOW AIR INTERFACE, SNOW TEMPERATURE, SNOW HEAT FLUX, TEMPERATURE MEASUREMENT, MILITARY OPERATION, ANALYSIS (MATHEMATICS), SURFACE TEMPERATURE, SNOW SURFACE.
Prediction of snow surface temperature is vital to the successful development of sensing devices and weapon systems. In this paper, a simplified mathematical analysis is made by assuming that the snow cover is dry and of uniform density. The computed results are expressed in terms of surface temperature response as a function of snow density and its effective thermal conductivity, and are compared with limited temporal field data. The results are found to be in reasonable agreement if an appropriate surface heat flux is chosen along with proper snow density and effective thermal conductivity. The same analysis is applied to a semi-infinite metallic plate. Because of its much greater thermal inertia value, the temperature response is much smaller, and this provides a considerable thermal contrast, which is essential for the development and use of the infrared sensors.

MP 2927
PORTABLE THERMAL REFERENCE FOR WINTER FIELD STUDIES.
Lacombe, J., *International Society for Optical Engineering. Proceedings,* 1990, Vol.1311, Characterization, propagation, and simulation of infrared scenes, Orlando, FL, Apr. 16-17, 19-20, 1990. p.48-54.
45-3769
INFRARED PHOTOGRAPHY, SNOW COVER EFFECT, TEMPERATURE MEASUREMENT, MILITARY EQUIPMENT, DETECTION, SUBSURFACE INVESTIGATIONS.
When documenting the infrared images of targets and backgrounds it is usually necessary to place one or more sources having known surface radiances within the field-of-view of the imaging system in order to calibrate the imagery. Although a variety of commercially available thermal references (i.e., "black bodies") exist they generally are very expensive and are not well suited for operating in the field under severe winter environmental conditions. A portable low-temperature thermal reference was recently developed at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) to calibrate infrared images of mines and snow backgrounds in winter.

MP 2928
EVALUATION OF EXISTING HYPOTHESES USED IN THE MATHEMATICAL DESCRIPTION OF ICE SEGREGATION IN FREEZING SOILS.
Nakano, Y., et al, [1990], 14p., Unpublished manuscript. 13 refs. For presentation at the 5th International Colloquium on Free Boundary Problems, Montreal, June 1990.
Takeda, K.
45-3770
SOIL FREEZING, FREEZING FRONT, MATHEMATICAL MODELS, ICE GROWTH, SOIL WATER MIGRATION, ICE LENSES.
The steady growth of a segregated ice layer in freezing soils was studied mathematically and experimentally under each of three distinct and representative hypotheses on the properties of the frozen fringe, chosen among many such hypotheses reported in the literature. The condition of steady growth was found to be determined by a set of two independent variables, such as the temperature gradient at the 0 C isotherm and that in the ice layer at the interface between ice layer and the frozen fringe, regardless of models. The results of the study clearly showed that one model is consistent with experimental data while the other two models contradict them.

MP 2929
WAVEFORM ANALYSIS OF ELECTROMAGNETIC SCATTERING FOR A THREE DIMENSIONAL TUNNEL.
Moran, M.L., et al, Annual International Meeting and Exposition of the Society of Exploration Geophysicists, 60th, San Francisco, Sep. 23-27, 1990. Proceedings, [1990], 4p., 9 refs.
Greenfield, R.J.
45-3771
TUNNELS, ELECTROMAGNETIC PROSPECTING, WAVE PROPAGATION, SUBSURFACE INVESTIGATIONS.
A three-dimensional numerical model simulating a cross-borehole electromagnetic survey in the presence of a cylindrical tunnel is developed and shown to compare well to field data. The model is based on an exact Green's function solution for a true vertically oriented unit electric dipole. Model simulations for tunnels filled with air, water and highly conducting material exhibit low amplitude shadow zones which extend along the entire length of the tunnel. This shadow zone is the most reliable indicator for the presence of a tunnel. Model results for air-filled tunnels in which the angle alpha, formed by a line normal to the tunnel axis and the line connecting the source and receiver is larger than 45 deg, indicate that the tunnel is effectively opaque to incident radiation. Beyond angles of alpha=45 deg arrivals in the shadow zone are dominated by energy which diffracts around the tunnel. It is also shown that moderate tunnel dips for air-filled tunnels do not appreciably affect waveforms. Comparisons of profiles in the vertical direction between air-filled and water-filled or highly conducting tunnels show that water-filled and highly conducting tunnels exhibit only minor waveform alteration as alpha increases. Water-filled tunnels also alter the latter half of the waveform.

MP 2930
PERFORMANCE OF AN EARTHQUAKE MOTION SIMULATOR FOR A SMALL GEOTECHNICAL CENTRIFUGE.
Ketcham, S.A., et al, Centrifuge 91, Rotterdam, A.A. Balkema, 1991, p.361-368, 7 refs. Proceedings of an international conference, Boulder, CO, June 13-14, 1991.
Ko, H.Y., Sture, S.
45-3772
EARTHQUAKES, ENGINEERING GEOLOGY, EMBANKMENTS, SIMULATION, HYDRAULIC STRUCTURES.
An electrohydraulic servocontrolled slip table system for earthquake motion simulation in a 15 g-ton geotechnical centrifuge is in operation at the University of Colorado. The performance of the system is illustrated here by measures of the slip table system response for a specific operating condition and by results from a model embankment experiment. It is shown that reasonable simulations of specific prototype-horizontal earthquake motions can be achieved using a signal correction technique which incorporates a measure of the system frequency response.

MP 2931
INTERPRETATION OF PASSIVE AND ACTIVE MICROWAVE IMAGERY OVER SNOW-COVERED LAKES AND RIVERS NEAR FAIRBANKS, ALASKA.
Melloh, R.A., et al, Workshop on Applications of Remote Sensing in Hydrology, Saskatoon, Saskatchewan, Feb. 13-14, 1990. Proceedings. Edited by G.W. Kite and A. Wankiewicz, Environment Canada, 1990, p.259-278, 14 refs.
Gatto, L.W.
45-3808
REMOTE SENSING, SNOW COVER, ICE CONDITIONS, RADIOMETRY, ICE JAMS, MICROWAVES, LAKE ICE, RIVER ICE, SYNTHETIC APERTURE RADAR.
Passive and active microwave imagery provide information about freshwater ice and snow environments needed for a better understanding of river and lake ice processes, winter stream habitats, winter water supply and ice management. The ability to image at night and through clouds is an advantage of microwave systems over shorter wavelength visible and infrared systems. Additionally, microwave imagers have a different sensitivity to ice and snow conditions and thus provide added capability to observe features that could not be detected with visible and infrared instruments. To exploit the imagery data fully, a better understanding of microwave signatures created by freshwater ice conditions is needed. An ongoing CRREL investigation interprets snow and ice conditions on lakes and rivers near Fairbanks, AK, using both passive and active microwave imagery taken in Mar. 1988 during both wet and dry snow conditions. The imagery includes that obtained with the Jet Propulsion Laboratory's Synthetic Aperture Radar (SAR) in quad-polarized (HH, VV, HV and VH) C-, L- and P-bands, and that obtained with NORDA's Ka-band Radiometric Mapping System. Ground truth data taken during overflights includes aerial video, observations of snow depth and stratigraphy, ice core descriptions and thickness measurements, and impulse radar traces. The field data and available experimental studies of microwave interactions with snow and ice are used to interpret imagery patterns. Results to date confirm that the microwave imagery distinguishes snow and ice conditions including open leads, wet overflows, ice jams, and main channels on the Tanana River, and fracture patterns and changing snow conditions on nearby lakes. The specific geophysical characteristics and conditions of river and lake ice that produced the imagery patterns are being investigated.

MP 2932
ANTARCTIC SEA ICE: A HABITAT FOR THE FORAMINIFER *NEOGLOBOQUADRINA PACHYDERMA*.
Dieckmann, G.S., et al, *Journal of foraminiferal research,* Apr. 1991, 21(2), p.182-189, 35 refs. For another version see 44-3824 or 18F-42109.
Spindler, M., Lange, M.A., Ackley, S.F., Eicken, H.
45-3837
SEA ICE, MARINE BIOLOGY, MICROBIOLOGY, ICE GROWTH, BIOMASS, ANTARCTICA—WEDDELL SEA.
The pelagic foraminifer *Neogloboquadrina pachyderma* (Ehrenberg, 1861) occurs in new ice, congelation ice, and the underlying water column of the Weddell Sea. *N. pachyderma* is incorporated into the ice in large numbers at the time of its formation. The average number of foraminifers per liter of ice was 87 and numbers ranged between 0 and 1,075. Sea ice contained 70 times more foraminifers per unit volume than the underlying water column, and on an areal basis the sea ice cover has approximately the same number of specimens as 60 m of underlying water column. The foraminifera are usually incorporated into the ice when it is being formed dynamically and are thus subsequently associated mainly with granular ice. Many foraminifers are able to survive and grow in the ice where algal biomass in winter is high compared to the water column, perhaps indicating an overwintering strategy. Arctic sea ice, on the other hand, is practically devoid of foraminifers. These observations may have implications for paleoceanographers who use *N. pachyderma* as a tool to reconstruct past surface water conditions. (Auth.)

MP 2933
MEMBRANE FOR IN SITU OPTICAL DETECTION OF ORGANIC NITRO COMPOUNDS BASED ON FLUORESCENCE QUENCHING.
Jian, C., et al, *Analytica chimica acta,* 1990, Vol.237, p.265-271, 10 refs.
Seitz, W.R.
46-23
GROUND WATER, WATER POLLUTION, SOIL POLLUTION, CHEMICAL ANALYSIS, EXPLOSIVES, DETECTION, OPTICAL PROPERTIES, POLYMERS.
Fluorescent membrane formulations for detecting organic nitro compounds by fluorescence quenching were evaluated. The most sensitive membrane is prepared by solvent casting from cyclohexanone to incorporate pyrenebutyric acid into cellulose triacetate plasticized with isodecyl diphenylphosphate. The response follows the Stern-Volmer law for 1,4,6-trinitrotoluene (TNT) and 2,4-dinitrotoluene (DNT). The membrane also responds to hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). For a given set of conditions, the primary factor determining sensitivity is the extent to which each nitro compound partitions into the membrane. Detection limits are ca. 2 mg/l for DNT and TNT and 10 mg/l for RDX. Nitrogen purging prior to the measurement enhances the sensitivity and eliminates interference from oxygen. The membrane is designed to be used for remote optical in situ screening of groundwater for contamination by explosives.

MP 2934
MECHANISMS CONTROLLING VEHICLE MOBILITY ON A THAWING SOIL.
Shoop, S.A., International Conference of the ISTVS, 10th, Kobe, Japan, Aug. 20-24, 1990. Proceedings, Vol.1, Hanover, NH, International Society for Terrain-Vehicle Systems, [1990], p.301-311, 6 refs.
46-42
GROUND THAWING, SOIL TRAFFICABILITY, TRACTION, THAW DEPTH.
Vehicle traction and motion resistance were tested on several freeze/thaw conditions of silty sand. Mobility tests were performed using an instrumented vehicle in a large test basin where soil temperature and saturation were controlled. The work aimed to determine how soil parameters influence vehicle mobility the most. When the soil water content is above the liquid limit, motion resistance sharply increases and traction declines rapidly. At these high water contents the thawed soil has little shear resistance, and any traction or motion resistance is provided by the hard frozen layer below. As the thaw depth increases, the vehicle sinks deeper into the soil, increasing the motion resistance. At depth, the strength contributions of the frozen layer become less effective and gross traction decreases. This results in low net traction for deep wet thaws. At low water contents, traction decreases with increasing thaw depth but resistance is constant. At water contents near the liquid limit, the soil strength is at a maximum and the depth of thaw does not significantly influence vehicle mobility.

MP 2935
TRI-SERVICE WORKSHOP ON CHEMICAL OPERATIONS IN COLD WEATHER, AUG. 1988.
Birenzvige, A., ed, *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, 298p., Refs. passim. For selected papers see 46-90 through 46-105.
Yurow, H.W., ed, Parker, L.V., ed.
46-89
MILITARY OPERATION, COLD WEATHER OPERATION, POLLUTION, CHEMICAL PROPERTIES, WASTE TREATMENT, COUNTERMEASURES, IMPURITIES, EXPLOSIVES.
The first tri-service workshop on chemical operations in cold weather was held on Aug. 16-17, 1988. The meeting was attended by representatives of different military R&D organizations, the user community, the intelligence community, and the medical community. Papers presented covered the whole gamut of the chemical cold battlefield including problems associated with detection of CB agents, protection (individual and collective) against contamination, and casualty treatment.

MP 2936
OVERVIEW OF COLD REGIONS RESEARCH AND ENGINEERING LABORATORY (CRREL).
Link, L.E., Jr., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker. p.13-14.
46-90
RESEARCH PROJECTS, MILITARY RESEARCH, ORGANIZATIONS, LABORATORIES.

MP 2937
CHEMICAL AGENT PERSISTENCE IN COLD WEATHER.
Leggett, D.C., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.43-60, 10 refs.
46-94
MILITARY OPERATION, COLD WEATHER OPERATION, POLLUTION, IMPURITIES, SOLUBILITY, ENVIRONMENTAL IMPACT, DECOMPOSITION, EVAPORATION, CHEMICAL PROPERTIES.
Knowledge of chemical agent persistence is necessary for adequate protection of personnel. Persistence is significantly affected both by low temperature and by physical/chemical interaction with snow or ice. Evaporation and hydrolysis appear to be the major decay mechanisms. Factors affecting evaporation can be divided into two categories, those that are independent of the substrate surface and those that depend on the type of surface. In the absence of surface effects, simple mathematical models such as the one developed by Chinn can be used to predict persistence. In case of ice and snow, however, theoretical considerations suggest that an agent evaporation model should at least take into account ice solubility in the agent. The presence of snow/ice also provides the potential for hydrolytic decomposition of the agents. Experimental work with the simulant DFP suggests that about a 2.5-fold decrease in hydrolysis rate occurs per 10 C decrease in temperature below 0 C. A total weathering model for chemical agents was derived using the data on DMMP evaporation and DFP hydrolysis.

MP 2938
SNOW-SMOKE AND SNOW-VAPOR INTERACTION.
Hogan, A.W., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.111-115, 3 refs.
46-98
FALLING SNOW, AIR POLLUTION, SCAVENGING, MILITARY OPERATION, SNOWFLAKES, SNOW AIR INTERFACE.

MP 2939
OPERATION OF ELECTRONIC EQUIPMENT IN WINTER CONDITIONS.
Atkins, R.T., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.121-128, 5 refs.
46-100
COLD WEATHER OPERATION, ELECTRONIC EQUIPMENT, MILITARY EQUIPMENT.

MP 2940
DECONTAMINATION OF CHEMICAL AGENTS ON A WINTER BATTLEFIELD—AN OVERVIEW.
Parker, L.V., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.173-184, 22 refs.
46-101
COLD WEATHER OPERATION, MILITARY OPERATION, POLLUTION, WASTE TREATMENT, COUNTERMEASURES, CHEMICAL PROPERTIES, ENVIRONMENTAL PROTECTION.

MP 2941
SURFACE EVAPORATION: EFFECT OF SUBSTRATE MATERIAL AND TEMPERATURE.
Lunardini, V.J., *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.225-237, 18 refs.
46-104
COLD WEATHER OPERATION, MILITARY OPERATION, POLLUTION, EVAPORATION, WASTE TREATMENT, ANALYSIS (MATHEMATICS), CHEMICAL PROPERTIES.
The decontamination of surfaces covered by chemical agents can be greatly accelerated by the use of a heated air stream impinging upon the surface. The actual rate of evaporation, for any agent, is a function of the thermal history of the agent. Thus, it was expected that the nature of the substrate upon which the agent is deposited could be significant. A preliminary estimate of the effect of cold climates on the process was carried out using a simple physical model of the evaporation. A thin layer of liquid and a semi-infinite substrate are initially at a constant temperature and are subjected to a convective heat transfer flux from the ambient air, also at a fixed temperature. The surface temperature of the liquid will increase until it reaches the normal boiling point. For simplicity, it is assumed that no evaporation takes place during this time. The liquid film then evaporates while its surface temperature remains at the boiling point. The analysis indicated that the substrate material and temperature will have a significant effect on the evaporation time. If the substrate is a good conductor, such as steel or aluminum, the evaporation time will greatly exceed the time needed to evaporate the same thickness from a semi-infinite layer of the substance. Also, an initial temperature of 10 F will require a significantly longer evaporation time than that for a temperature of 70 F. Predictions have been made for various thicknesses of water and HD on steel or bakelite surfaces.

MP 2942
MULTIPLE WISCONSINAN GLACIGENIC SEQUENCES AT WEDRON, ILLINOIS.
Johnson, W.H., et al, *Journal of sedimentary petrology,* Jan. 1990, 60(1), p.26-41, 56 refs.
Hansel, A.K.
46-110
LITHOLOGY, GLACIAL DEPOSITS, SEDIMENT TRANSPORT, STRATIGRAPHY, GLACIER OSCILLATION, SUBGLACIAL OBSERVATIONS, MORAINES.

MP 2943
DEVELOPMENT OF FIELD SCREENING METHODS FOR TNT AND RDX IN SOIL AND GROUND WATER.
Jenkins, T.F., et al, International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals, 2nd, Feb. 12-14, 1991, U.S. Environmental Protection Agency, 1991, p.683-686, 6 refs.
Walsh, M.E., Stutz, M.H., Lang, K.T.
46-109
SOIL POLLUTION, EXPLOSIVES, GROUND WATER, WATER POLLUTION, SOIL ANALYSIS, LABORATORY TECHNIQUES, SAMPLING, CHEMICAL ANALYSIS.
One of the most serious environmental problems facing the Army is the presence of soil contaminated with residues of high explosives at sites where the munitions were formerly manufactured, stored, used or demilitarized. TNT and RDX are the two residues most commonly encountered because these explosives were extensively produced and do not rapidly decompose. Since TNT and RDX leach through the unsaturated zone with downward percolating water, they pose an immediate problem to ground water; thus contaminated soil must be treated or isolated. Although laboratory methods for analyzing munitions residues in soil and water are now available, reliable field methods are also desirable so that zones of high contamination can be located during initial surveys and the interface between clean soil and contaminated soil identified during cleanup. In this paper, the development of such a field method is described.

MP 2944
ANALYSIS OF FROST SHIELDS USING THE FINITE ELEMENT METHOD.
Coutermarsh, B.A., et al, International Conference on Numerical Methods in Thermal Problems, 7th, Stanford, CA, July 8-12, 1991. ` Proceedings, Vol.7, Pt.1. Edited by R.W. Lewis et al, Swansea, UK, Pineridge Press, 1991, p.123-132, 13 refs.
Phetteplace, G.E.
46-108
SOIL FREEZING, FROST PROTECTION, UNDERGROUND PIPELINES, COVERING, DESIGN, HEAT TRANSFER, MATHEMATICAL MODELS, COMPUTERIZED SIMULATION, WATER TEMPERATURE.
In this paper, a finite element (FE) program has been developed to solve two-dimensional heat transfer problems with phase change. This program has been used to assess the practicality of frost shielding techniques. The term "frost shielding" describes the practice of using rigid board insulation to protect buried water or sewer pipes within the frost zone from freezing. This allows the burial depth to be reduced, resulting in lower installation and maintenance costs.

MP 2945
ICE WHARF ENQUIRY. REPORT OF THE NSF TASK FORCE.
Mellor, M., et al, Washington, D.C., Division of Polar Programs, National Science Foundation, June 1991, 18p. + Attachments 1-23 separately bound, Refs. passim. For papers included as some of the attachments, see 26-3532, 32-296, 32-1631, 38-278, 38-2176, and 44-829, or 9G-18892, 10G-19487, 13G-28590, 14G-29316, or 17F-40759.
Barthelemy, J.L., Fitzsimmons, G.J., Haehnle, R.J., Weeks, W.F.
46-170
ICE WHARVES, ICE CRACKS, ICE BREAKUP, ICE (CONSTRUCTION MATERIAL), ANTARCTICA—MCMURDO STATION.
This is the report of a task force appointed by the National Science Foundation to investigate the occurrence of two major cracks which caused the ice wharf at McMurdo Station to break into three large fragments on Feb. 13, 1991. The cargo ship *Green Wave* had just been unloaded and all personnel and material were removed before the breakup. Previous ice wharves were built in 1973, 1976 and 1983, and the present one in Mar.-Sep. 1990, by pumping sea water over the surface and letting the water freeze. It is suggested that the cause of the cracks was most probably flexural failure induced by long-wave swells of about 200 m. Other suggested causes such as concentrated vertical loads from empty shipping containers, ship impact, or bending moments from ship mooring lines, do not seem to have been strong enough in this case. An initial average ice thickness of 20 ft rather than 11 ft and two layers of reinforcing cables rather than one are recommended for future ice wharves.

MP 2946
DIELECTRIC CONSTANT AND LAYER-THICKNESS INTERPRETATION OF HELICOPTER-BORNE SHORT-PULSE RADAR WAVEFORMS REFLECTED FROM WET AND DRY RIVER-ICE SHEETS.
Arcone, S.A., *IEEE transactions on geoscience and remote sensing,* Sep. 1991, 29(5), p.768-777, 19 refs.
46-211
RIVER ICE, ICE COVER THICKNESS, DIELECTRIC PROPERTIES, RADAR ECHOES, AIRBORNE RADAR, MELTING, WAVE PROPAGATION, ICE BOTTOM SURFACE, ICE WATER INTERFACE.
Analysis of short-pulse radar data taken over river ice sheets in late spring reveals that radar signal penetration of an ice sheet and determination of its thickness are not necessarily prevented by the presence of surface water or internal melting. Radar data for both wet and dry ice were extracted from surveys performed from a helicopter operating at an altitude of about 2-7 m and a speed of about 5 m/s over the Connecticut River near Windsor, Vermont. The radar used a broadband wavelet of several nanoseconds duration at a center frequency of about 500 MHz. By use of plane wave theory, the dielectric constant of ice is interpreted from the amplitudes of reflections from a solid ice sheet. This verification of plane-wave interpretation and the lack of dispersion seen in wet ice bottom returns are then used to interpret data from segments of a wet ice sheet survey for both ice thickness and surface water depth. Other ice sheet segments, for which the data allow only sporadic interpretation of ice depth, are interpreted as having internal melting. It is concluded that ice thickness can be determined for surface water layers less than about 8 mm thick for the particular wavelet used, so long as the ice interfaces are not severely rough.

MP 2947
AGITATION AND FILTERABILITY OF FREEZE/THAWED SLUDGE.
Vesilind, P.A., et al, *Journal of cold regions engineering,* June 1991, 5(2), p.77-83, 25 refs.
Hung, W.Y., Martel, C.J.
46-282
SLUDGES, WASTE TREATMENT, FREEZE THAW CYCLES, PERFORMANCE, WATER TREATMENT, VIBRATIONS, PARTICLE SIZE DISTRIBUTION.
Particle size has opposing effects on the effectiveness of freeze/thaw sludge conditioning. Small particles migrate easily and coagulate into larger particles during freezing, but small particles also cause poor sludge dewaterability. Since agitation can change particle size, the effects of agitation on sludge dewatering before and after freeze/thaw conditioning is of practical significance. The capillary suction time (CST) device is used to measure the dewaterability of several water and wastewater treatment sludges before and after freeze/thaw. The results show that preagitation may have a detrimental effect on the dewaterability of some sludges after freeze/thaw conditioning. For other sludges such as raw primary sludges that have large initial particle size distributions, agitation prior to freeze/thaw will not be detrimental to subsequent dewatering. Postagitation clearly has a substantial deleterious effect on dewaterability, leading to the conclusion that if freeze/thaw is used for conditioning, the thawed sludge should undergo minimum agitation before dewatering. (Auth.)

MP 2948
PERFORMANCE OF AIRPORT PCC PAVEMENTS DURING SPRING THAW PERIODS.
Janoo, V.C., et al, Aircraft/pavement interaction; an integrated system. Edited by P.T. Foxworthy, New York, American Society of Civil Engineers, 1991, p.306-322, 13 refs. Proceedings of a conference, Kansas City, MO, Sep. 4-6, 1991.
Berg, R.L., Tomita, H.
46-314
PAVEMENTS, RUNWAYS, THAW WEAKENING, SEASONAL FREEZE THAW, CONCRETES.
The portland cement concrete (PCC) pavements at two Wisconsin airports, central Wisconsin Airport in Mosinee, and Outagamie County Airport in Appleton, were monitored during spring thaw in 1986. To evaluate pavement performance during this period, falling weight deflections were taken. In addition, surface and subsurface temperatures were measured at selected sites at the two airports. Since the current Federal Aviation Administration PCC pavement design criterion is based on limiting the bending stresses in the concrete slab under edge loading conditions, the major portion of the evaluation was on load transfer during the spring thaw period. This paper presents the results of the field study at these two airports.

MP 2949
FIRE SEVERITY, ASH DEPOSITION, AND CLIPPING EFFECTS ON SOIL NUTRIENTS IN CHAPARRAL.
Marion, G.M., et al, *Soil Science Society of America. Journal,* Jan.-Feb. 1991, 55(1), p.235-240, 22 refs.
Moreno, J.M., Oechel, W.C.
46-316
FOREST FIRES, SOIL CHEMISTRY, NUTRIENT CYCLE.
Fire may affect soil nutrient status by direct addition of nutrients and by indirectly altering the soil environment. The objective of this study was to examine how fire severity, ash deposition, and clipping affect posttreatment soil nutrient status. There were eight experimental treatments designed to examine increasing fire severity, ash (nutrient) addition independent of fire severity, clipping to study competition for nutrients per se, and untreated controls. Fire severity affected both the quality and quantity of ash. Increasing fire severity increased the concentrations of Mg and K and decreased the concentrations of NH4-N and NO3-N in the ash. As fire severity increased, there was an increasing recovery of ash relative to standing biomass (10-18 g/kg). Fire increased the availability of all nutrients (NH4-N, NO3-N, PO4-P, Ca, Mg and K). This nutrient enhancement was largely restricted to the surface soil (0-5 cm); only soluble N appeared to increase in the subsurface soil (5-10 cm). The soil quantities of NH4-N increased and NO3-N decreased with increasing fire severity, suggesting either a direct addition of variable amounts of these N ions or an indirect effect on postfire nitrification rates. Clipping had no effect on enhancing soil nutrient availability. The apparent recovery of the basic cations in the water extracts of the ash samples was in the order: K>>Mg>Ca; this was different from the subsequent recovery in the soil: Ca>K>Mg. It was hypothesized that the relative recovery of basic cations in the water extracts of the ash samples was controlled by the solubility of Ca, Mg, and K salts.

MP 2950
STRENGTH DEVELOPMENT OF CONCRETE CURED AT LOW TEMPERATURE.
Korhonen, C.J., et al, Corps of Engineers Structural Engineering Conference, Jacksonville, FL, July 8-12, 1991, Washington, D.C., Directorate of Engineering and Construction, 1991, p.1-9, 7 refs.
Cortez, E.R., Charest, B.A.
46-349
CONCRETE CURING, WINTER CONCRETING, CONCRETE ADMIXTURES, CONCRETE STRENGTH.
Long winters, emergency repairs, or simply a tight schedule may force an engineer to look for ways to cast concrete for structural applications during cold weather. Under adverse conditions such as these, concreting has almost always entailed expensive and time-consuming methods of protecting the fresh concrete from freezing temperatures. A newer approach is the use of chemical admixtures that depress the freezing point of water and allow concrete to gain strength at temperatures that are damaging to normal concrete. This paper discusses a study of a series of chemicals that were tested for their effect on strength gain in concrete cured at various low temperatures. The results show that appreciable strength can be promoted in concrete cured at temperatures below freezing when these chemicals are used.

MP 2951
OVERVIEW OF SMOKE AND OBSCURATION IN THE WINTER.
Green, J., et al, *U.S. Army Chemical Research, Development and Engineering Center. Special publication,* Jan. 1990, CRDEC-SP-019, Tri-Service Workshop on Chemical Operations in Cold Weather, Aug. 1988. Edited by A. Birenzvige, H.W. Yurow, and L.V. Parker, p.99-109, 7 refs.
Erickson, M., Redfield, R.
46-97
MILITARY OPERATION, COLD WEATHER OPERATION, AIR POLLUTION, SMOKE GENERATORS, SNOW OPTICS, VISIBILITY, ATMOSPHERIC ATTENUATION.

MP 2952
THAW RESPONSE OF TUSSOCK-SHRUB TUNDRA TO EXPERIMENTAL ALL-TERRAIN VEHICLE DISTURBANCES IN SOUTH-CENTRAL ALASKA.
Racine, C.H., et al, *Arctic,* Mar. 1991, 44(1), p.31-37, With French summary. 12 refs.
Ahlstrand, G.M.
46-382
TUNDRA, LOADING, ALL TERRAIN VEHICLES, BEARING STRENGTH, GROUND THAWING, THAW DEPTH, ENVIRONMENTAL IMPACT, MECHANICAL TESTS, SUBSURFACE INVESTIGATIONS.
A perennial snowbank located in the continuous permafrost zone was cored to obtain details of its internal structure and history. In spring the snowbank is up to 10 m thick and composed of deep snow accumulated during the previous winter, overlying ice developed by basal ice accretion over many years. The perennial ice exhibits a layered structure with alternating clear and milky bands, and contains randomly oriented, variably shaped bubbles. Horizons of aeolian and mudflow deposits occur at irregular intervals and correspond to periods of aggradation and thaw truncation of the snowbank. Tritium concentrations in a core from the deepest portion of the snowbank indicate that the basal 2 m of ice pre-dates 1957. Other layers of ice likely represent precipitation that fell between 1958 and 1962, between 1968 and 1976, and after 1983. Ice developed during the 1963 atmospheric tritium peak is no longer present. Energy balance measurements indicate that potential climatic warming is unlikely to eliminate the perennial portion of the snowbank unless accompanied by substantially less snow drifting at the site.

MP 2953
STATISTICAL DESCRIPTION OF THE MICROSTRUCTURE OF YOUNG SEA ICE.
Perovich, D.K., et al, *Journal of geophysical research,* Sep. 15, 1991, 96(C9), p.16,943-16,953, 23 refs.
Gow, A.J.
46-412
SEA ICE, YOUNG ICE, ICE MICROSTRUCTURE, ICE CRYSTAL OPTICS, MICROWAVES, ICE MODELS, STATISTICAL ANALYSIS, IMAGE PROCESSING, SALINITY, CORRELATION, RADIOMETRY.
In order to fully exploit microwave models of sea ice, the standard ice characterization must be supplemented by a statistical description of the ice microstructure. For the strong fluctuation theory this statistical description takes the form of the mean and variance of the permittivity plus correlation lengths. In this paper, we have computed these statistics for over 50 samples of young ice, including both columnar congelation ice and desalinated bubbly ice, which were taken from different vertical depths and horizontal positions within the ice sheet and encompassed a comprehensive range of ice temperatures and brine volumes. For each of these samples, horizontal thin sections were photo-

graphed, then digitized and analyzed on a personal computer-based image processing system. Results indicate that correlation lengths correspond to the physical dimensions of the inclusions.

MP 2954
FLOW DISTRIBUTION IN MULTIPLE CHANNELS WITH PARTIAL ICE COVERAGE.
Ashton, G.D., National Conference on Hydraulic Engineering, San Diego, CA, July 30-Aug. 3, 1990. Proceedings. Edited by H.H. Chang et al, New York, NY, American Society of Civil Engineers, 1990, p.32-38, 1 ref.
46-458
CHANNELS (WATERWAYS), RIVER FLOW, ICE WATER INTERFACE, RIVER ICE, ICE COVER EFFECT, ANALYSIS (MATHEMATICS), ROUGHNESS COEFFICIENT, HYDRAULICS.

MP 2955
CONCURRENT REMOTE SENSING OF ARCTIC SEA ICE FROM SUBMARINE AND AIRCRAFT.
Wadhams, P., et al, *International journal of remote sensing*, Sep. 1991, 12(9), p.1829-1840, 8 refs. For other versions see 44-3376 and 45-563.
Davis, N.R., Comiso, J.C., Kutz, R., Crawford, J., Jackson, G., Krabill, W., Sear, C.B., Swift, R., Tucker, W.B.
46-462
ICE SURVEYS, SEA ICE, AERIAL SURVEYS, ICE SURFACE, SUBGLACIAL OBSERVATIONS, CORRELATION, CLASSIFICATIONS, ACOUSTIC MEASUREMENT, SYNTHETIC APERTURE RADAR, SUBMARINES, RADIOMETRY, LASERS.
In May 1987 a concurrent remote sensing study of arctic sea ice from above and below was carried out. A submarine equipped with sidescan and upward looking sonar collaborated with two remote sensing aircraft equipped with passive microwave, synthetic aperture radar (SAR), a laser profilometer and an infrared radiometer. By careful registration of the three tracks it has been possible to find relationships between ice type, ice morphology and thickness, SAR backscatter and microwave brightness temperatures. The key to the process has been the sidescan sonar's ability to identify ice type through differences in characteristic topography. Over a heavily ridged area of mainly multiyear ice there is a strong positive correlation between SAR backscatter and ice draft or elevation. It was also found that passive and active microwave complement each other in that SAR has a high contrast between open water and multiyear ice, while passive microwave has a high contrast between open water and first-year ice. (Auth. mod.)

MP 2956
ON THE STABLE GROWTH OF SEGREGATED ICE IN FREEZING SOIL UNDER NEGLIGIBLE OVERBURDEN PRESSURE.
Nakano, Y., *Advances in water resources*, Dec. 1986, 9(4), p.223-235, 10 refs.
46-470
SOIL FREEZING, SOIL WATER MIGRATION, ICE GROWTH, ICE LENSES, SOIL PRESSURE, FROST HEAVE, MINERALS, ANALYSIS (MATHEMATICS), FROZEN GROUND MECHANICS.
The stable growth condition of a segregated ice layer is studied by the use of the principle of mass and heat conservation. This condition evidently depends upon the properties of a thin transitional zone, which is believed to exist between the boundary of an ice layer and a 0 C isotherm. All probable models of the transitional zone are classified and the conditions for each model is derived. The effect of the small amount of soil minerals contained in an ice layer is also studied.

MP 2957
SURFACE DECOUPLING ABOVE SNOW-COVERED TERRAIN.
Hogan, A.W., et al, Electro-Optical Systems Atmospheric Effects Library/Tactical Weather Intelligence (EOSAEL/TWI) Annual Conference, 11th, Las Cruces, NM, Nov. 27-30, 1990. Proceedings, U.S. Army Atmospheric Sciences Laboratory, 1991, p.120-131, 24 refs.
Ferrick, M.G.
46-502
SNOW AIR INTERFACE, SNOW TEMPERATURE, SURFACE TEMPERATURE, TEMPERATURE INVERSIONS, TEMPERATURE VARIATIONS, SNOW COVER EFFECT.
Inversions and multiple inversions frequently decouple the boundary layer above snow-covered ground from the prevailing tropospheric flow. This decoupling is strongly evident over areas of great local relief; experiments in the Connecticut River Valley showed the surface at many elevations to be decoupled from the lower troposphere during the winter of 1989-1990. Experimental measurements of surface air temperature near the time of sunrise indicated lags of 8 C over level ground accompanying warm advection. Morning temperature differences of 10 C were found over horizontal distances of 3 km and elevation differences of 200 m. The greatest temperature differences were found on cloudless mornings, but many cloudy mornings had terrain-related temperature variations of 2 C or greater. Temperatures over frozen bodies of water differed from those of adjacent terrain, with this temperature difference related to amount of snow cover, slope of adjacent terrain, and rate of ice production on the water body. This surface decoupling can complicate operational forecasting or nowcasting of infrared temperature contrast, optical surface definition, radar ducting, glazing or riming, and the freezing of water surfaces. Some analytical techniques are described.

MP 2958
REPORT ON THE GLACIER RESEARCH WORKSHOP, FEBRUARY 5-7, 1991, EAGLE RIVER, ALASKA.
Sturm, M., et al, National Park Service, 1991, 16p., 11 refs.
Taylor, D., Benson, C., Nelson, G.
46-548
GLACIER SURVEYS, MEETINGS, RESEARCH PROJECTS, ORGANIZATIONS, MONITORS, CLIMATIC CHANGES, GLACIER OSCILLATION.

MP 2959
TENSILE TESTING OF EIFS LAMINAS.
Flanders, S.N., et al, ASTM Special technical publication, STP 1116. Insulation materials: testing and application, 2nd volume. Edited by R.S. Graves and D.C. Wysocki, Philadelphia, PA, American Society for Testing and Materials, 1991, p.619-632, 2 refs.
Lampo, R.G., Davies, A.G., Jr.
46-582
THERMAL INSULATION, TENSILE PROPERTIES, WALLS, THERMAL STRESSES, STRAIN TESTS, JOINTS (JUNCTIONS), CRACKING (FRACTURING).
Information about tensile properties of exterior insulation finish system (EIFS) laminas has been unavailable to the engineering profession. Knowledge of the tensile properties of the reinforced laminas over the exterior surface of the insulation is key to EIFS performance and establishing rules for spacing expansion and control joints for different thicknesses in different climates.

MP 2960
HISTORICAL AND RECENT DEVELOPMENTS IN THE RESEARCH OF COLD REGIONS HEAT TRANSFER—ICE IN AIR, WATER AND EARTH.
Cheng, K.C., et al, Freezing and melting heat transfer in engineering: selected topics on ice-water systems and welding and casting processes. Edited by K.C. Cheng and N. Seki, New York, Hemisphere Publishing Corporation, 1991, p.17-62, 465 refs.
Yen, Y.C.
46-601
HEAT TRANSFER, ICE FORMATION, ICING, SOIL FREEZING, HISTORY, BIBLIOGRAPHIES, RIVER ICE, LAKE ICE, PERMAFROST.
A brief review of historical and recent developments of ice formation problems in air, water and earth was made covering such subjects as atmospheric and marine icings of structures, permafrost and ground freezing (frost heave), river and lake ice (frazil ice and supercooling), arctic oil and gas pipelines, and heat transfer with freezing and melting from the unified viewpoint of cold regions heat transfer. An attempt was made to review the varied technical fields involving ice formation phenomena from the common viewpoint of heat transfer, to show the scope and subjects of cold regions heat transfer engineering.

MP 2961
CONDUCTION WITH FREEZING AND THAWING.
Lunardini, V.J., Freezing and melting heat transfer in engineering: selected topics on ice-water systems and welding and casting processes. Edited by K.C. Cheng and N. Seki, New York, Hemisphere Publishing Corporation, 1991, p.65-129, 92 refs.
46-602
HEAT TRANSFER, CONDUCTION, SOIL FREEZING, GROUND THAWING, ANALYSIS (MATHEMATICS), STEFAN PROBLEM, PHASE TRANSFORMATIONS.
Conduction of heat transfer with solidification is a subset of the mathematical theory called Stefan problems or moving boundary problems. The exact solutions available are examined in some detail to yield insight into useful techniques, but approximate methods tend to be more useful for practical engineering problems. The concepts involved in the heat balance integral method, the quasi-static method, and perturbation methods are noted. Graphs are presented to aid in the application of theory to practical problems, especially those dealing with soil systems. Numerical methods and problems with significant convective aspects have not been examined, nor has an attempt been made to do more than survey the literature of conduction heat transfer with phase change.

MP 2962
ONSET OF CONVECTION AND HEAT TRANSFER CHARACTERISTICS IN ICE-WATER SYSTEMS.
Yen, Y.C., Freezing and melting heat transfer in engineering: selected topics on ice-water systems and welding and casting processes. Edited by K.C. Cheng and N. Seki, New York, Hemisphere Publishing Corporation, 1991, p.261-314, 34 refs.
46-608
CONVECTION, ICE WATER INTERFACE, HEAT TRANSFER, ICE MELTING, PHASE TRANSFORMATION, ANALYSIS (MATHEMATICS), DENSITY (MASS/VOLUME).
This review discusses the problems associated with the anomalous temperature-density relations of water. It deals with the subjects of onset of convection, the temperature structure and natural convective heat transfer and the laminar forced convective heat transfer in the water/ice system. The onset of convection in a water/ice system was found to be dependent on thermal boundary conditions, not a constant value as in the classical fluids. This system also exhibits a unique temperature distribution in the melt layer immediately after the critical Rayleigh number is exceeded, and soon after it establishes a more or less constant temperature region which expands to about two-thirds of the melt layer depth. The constant temperature is approximately 3.2 C for water layer formed from melting above, but varies for melt layers formed from below. The heat flux across the water/ice interface was found to be a weak power function and to increase linearly with temperature for melt layer formed from above and below, respectively. Both theoretical and experimental melting studies of ice spheres, cylinders and vertical plates show a minimum heat flux at the inversion temperature ranging from 5.1 to 5.6 C. For the case of laminar forced convection melting heat transfer, the presence of an interfacial velocity reduces heat transfer in comparison with the case without phase change.

MP 2963
FRAZIL ICE.
Daly, S.F., Freezing and melting heat transfer in engineering: selected topics on ice-water systems and welding and casting processes. Edited by K.C. Cheng and N. Seki, New York, Hemisphere Publishing Corporation, 1991, p.523-544, 21 refs.
46-615
FRAZIL ICE, ICE FORMATION, ICE CRYSTAL GROWTH, HEAT TRANSFER, ICE CRYSTAL COLLISION, NUCLEATION, ANALYSIS (MATHEMATICS).
A physically based quantitative model of frazil ice in natural water bodies, which describes the dynamic evolution of the frazil crystal size distribution function, is developed. The crystal number continuity equation and the heat balance for a differential volume serve as the basis for the model. The crystal growth rate and secondary nucleation rate are the major parameters that appear in these equations. Expressions for both are derived. The crystal growth rate is controlled by the heat transfer rate from the crystal to the supercooled water, which is shown to be a function of the crystal size, the fluid turbulence and the fluid properties. Secondary nucleation is assumed to be caused by collisions, which cause fragments of the crystals to shear off. These fragments become new crystals.

MP 2964
QUASI-STEADY PROBLEMS IN FREEZING SOILS: 3. ANALYSIS OF EXPERIMENTAL DATA.
Nakano, Y., et al, *Cold regions science and technology*, Aug. 1991, 19(3), p.225-243, 24 refs.
Takeda, K.
46-639
SOIL FREEZING, FROST HEAVE, ICE LENSES, ICE GROWTH, FROZEN GROUND EXPANSION, WATER PRESSURE, MATHEMATICAL MODELS, FREEZING FRONT, PHASE TRANSFORMATIONS, TEMPERATURE GRADIENTS.
The results of mathematical and experimental studies presented in the two earlier papers in this series (parts I and II) on the three distinct and representative models of a frozen fringe, M-1, M-2, and M-3, clearly show that the model M-1 is consistent with the experimental data while the empirical evidence against M-2 and M-3 is overwhelming. In this work the properties of the model M-1 are further examined by analyzing the experimental data in detail. It is found that the properties of a frozen fringe based on the model M-1 are consistent with the experimental data, and that the predicted steady growth condition of an ice layer is in excellent agreement with the condition found empirically.

MP 2965
SEASONAL CHANGES IN SEA ICE OPTICAL PROPERTIES DURING FALL FREEZE-UP.
Perovich, D.K., *Cold regions science and technology*, Aug. 1991, 19(3), p.261-273, 27 refs.
46-642
SEA ICE, OPTICAL PROPERTIES, FREEZEUP, ALBEDO, SNOW COVER EFFECT, RADIANCE, SEASONAL VARIATIONS, ICE OPTICS, SALINITY, LIGHT TRANSMISSION, PHOTOSYNTHESIS.

During the seasonal transition from summer to winter conditions, a sea ice cover undergoes a profound transformation. As the air temperature drops, the ice cools, the brine volume decreases, melt ponds freeze, new ice forms in areas of open water, and the surface becomes snow-covered. There is a corresponding change in the optical properties of the ice cover, with albedos increasing and transmittances decreasing. Measurements of spectral albedos, reflectances and incident irradiances were made at visible and near-infrared wavelengths (400-1100 nm) during fall freeze-up. In general, albedos increased as freeze-up progressed, with the increase being most pronounced at shorter wavelengths. The greatest temporal changes occurred in a freezing lead where, in only a few days, albedos increased from 0.1 for open water to 0.9 for snow-covered young ice. The evolution of the transmitted radiation field under the ice was estimated using a two-stream, multilayer radiative transfer model in conjunction with observations of ice morphology and thickness. Transmission decreased dramatically due to ice cooling, snowfall, and declining incident solar irradiances. Light transmission through young ice was two orders of magnitude greater than through snow-covered multiyear ice.

MP 2966
SOUNDING SEA ICE THICKNESS USING A PORTABLE ELECTROMAGNETIC INDUCTION INSTRUMENT.
Kovacs, A., et al, International Conference on Port and Ocean Engineering under Arctic Conditions, 11th, St. John's, Sep. 24-28, 1991. Proceedings. POAC 91. Vol.1. Edited by D.B. Muggeridge, D.B. Colbourne, and H.M. Muggeridge, St. John's, Memorial University of Newfoundland, 1991, p.332-343, 9 refs.
Morey, R.M.
46-717
ICE COVER THICKNESS, SOUNDING, ELECTROMAGNETIC PROSPECTING, ICE SURVEYS, SNOW DEPTH, SEA ICE.
Field trials using a man-portable Geonics Ltd. EM31 electromagnetic induction sounding instrument with a Flow Research Inc. plug-in data processing module for the remote measurement of sea ice thickness are discussed. It was found that the instrument was capable of estimating the snow plus ice thickness to within 10% of the true value for ice from about 0.7 to 3.5 m thick. Seawater under the Arctic Ocean pack ice has a relatively uniform conductivity (2.5 +/- 0.05 S/m). Because of this, a simplified method can be used for estimating sea ice thickness using an off-the-shelf EM31 instrument. This measurement technique is also discussed.

MP 2967
WAVE INDUCED CHAOTIC MOTION OF BERGY-BITS.
Hinchey, M.J., et al, International Conference on Port and Ocean Engineering under Arctic Conditions, 11th, St. John's, Sep. 24-28, 1991. Proceedings. POAC 91. Vol.2. Edited by D.B. Muggeridge, D.B. Colbourne, and H.M. Muggeridge, St. John's, Memorial University of Newfoundland, 1991, p.823-835, 5 refs.
Muggeridge, D.B., Rzentkowski, G., Lever, J.H.
46-747
ICEBERGS, WATER WAVES, OFFSHORE STRUCTURES, ICE SOLID INTERFACE, ICE MECHANICS, MATHEMATICAL MODELS.
Bergy-bits in waves pose a danger to offshore oil rigs. Recently, scale models of bergy-bits were subjected to random waves in the wave tank facility at Memorial University of Newfoundland (MUN) and their motions near a model rig were recorded using a SELSPOT system. Impact statistics were generated from the data using standard procedures. In regular waves, impact behavior was found to be very sensitive to small disturbances to the berg motion, especially near its heave resonance. This is a sign of chaos. The present paper explores this phenomenon in greater detail. It uses the Liapunov characteristic exponent concept for strange attractors to theoretically explore for chaos in the wave excited motion of a spherical berg free to move in heave only. The predicted regions of chaos for the berg are found to agree qualitatively with preliminary data from a wave tank set-up.

MP 2968
NORTH AMERICAN PARTICIPATION IN THE WMO SOLID PRECIPITATION MEASUREMENT INTERCOMPARISON.
Metcalfe, J.R., et al, *Western Snow Conference. Proceedings,* 1991, 59th, p.126-129, 13 refs.
Hanson, C.L., Pangburn, T., Goodison, B.E., Bates, R.
46-801
MEASUREMENT, MEASURING INSTRUMENTS, PRECIPITATION GAGES, SNOWFALL, SNOW WATER EQUIVALENT.

MP 2969
MICROFRACTURE AND THE COMPRESSIVE FAILURE OF POLYCRYSTALLINE ICE.
Cole, D.M., IUTAM/IAHR Symposium, St. John's, Newfoundland, 1989. Ice-structure interaction. Edited by S.J. Jones, R.F. McKenna, J. Tillotson, and I.J. Jordaan, Berlin, Springer-Verlag, 1991, p.231-249, 21 refs.
46-845
ICE DEFORMATION, ICE CRACKS, ICE PRESSURE, ICE STRENGTH, ICE CRYSTALS, ICE MICROSTRUCTURE.
This paper discusses strain rate and grain size effects on the process of microcrack nucleation in freshwater polycrystalline ice. It also examines crack nucleation mechanisms that are likely to operate under conditions of practical concern. Special attention is paid to the ductile-to-brittle transition and the role of grain size in the transition region. Experimental results on granular ice having bonded end caps revealed that there was a distinct beginning and end to the crack nucleation stage prior to brittle compressive failure. Straining at a rate of .001/s generated a population of stable microcracks over a certain range of stress; after this nucleation stage, the specimen continued to sustain increased loading up to the point of failure without extension of the existing cracks or nucleation of additional cracks.

MP 2970
PROBABILISTIC DETERMINATION OF ICEBERG COLLISION DESIGN LOADS FOR FLOATING PRODUCTION VESSELS.
Fuglem, M.K., et al, IUTAM/IAHR Symposium, St. John's, Newfoundland, 1989. Ice-structure interaction. Edited by S.J. Jones, R.F. McKenna, J. Tillotson, and I.J. Jordaan, Berlin, Springer-Verlag, 1991, p.459-482, 21 refs.
Duthinh, D., Lever, J.H., Jordaan, I.J.
46-856
ICE LOADS, ICEBERGS, FLOATING STRUCTURES, ICE SOLID INTERFACE, IMPACT STRENGTH, DESIGN CRITERIA, STATISTICAL ANALYSIS.
A probabilistic method is presented for estimating global iceberg collision design loads for floating production vessels. Preliminary design loads are estimated for a concrete semi-submersible at the Terra-Nova site on the northeast part of the Grand Banks. A large number of simulated iceberg collision loads are determined using Monte Carlo techniques to choose the required input parameters (such as iceberg size and collision velocity) from estimated distributions. Using the probability distribution of these loads and the estimated frequency of iceberg collisions, design loads corresponding to probabilities of excess of .001 and .0001 per year are estimated. The results are presented as curves giving the design load as a function of the success of the operators in detecting and avoiding icebergs.

MP 2971
ICE-STRUCTURE INTERACTION DURING INDENTATION TESTS.
Sodhi, D.S., IUTAM/IAHR Symposium, St. John's, Newfoundland, 1989. Ice-structure interaction. Edited by S.J. Jones, R.F. McKenna, J. Tillotson, and I.J. Jordaan, Berlin, Springer-Verlag, 1991, p.619-640, 17 refs.
46-863
ICE LOADS, ICE SOLID INTERFACE, ICE BREAKING, IMPACT TESTS, PENETRATION TESTS, ICE DEFORMATION, ICE STRENGTH.
To study dynamic ice-structure interaction during crushing failure of ice, indentation tests were conducted by pushing a vertical, flat indentor into the edges of floating ice sheets. The indentor was supported on three load cells to measure interaction forces at the interface. The displacements of the carriage and the indentor were measured separately. These measurements provided comprehensive data on the dynamic ice-structure interaction during crushing failure of an ice sheet. Three basic modes of ice behavior were observed: creep deformation at low velocities, intermittent crushing at intermediate velocities, and continuous crushing at high velocities. Based on these measurements, a theoretical model is proposed which produces results similar to those of the experiments.

MP 2972
METHOD OF SCALING FOR SHIP-ICE MODEL TESTS.
Colbourne, D.B., et al, IUTAM/IAHR Symposium, St. John's, Newfoundland, 1989. Ice-structure interaction. Edited by S.J. Jones, R.F. McKenna, J. Tillotson, and I.J. Jordaan, Berlin, Springer-Verlag, 1991, p.715-729, 11 refs.
Lever, J.H.
46-867
ICEBREAKERS, ICE BREAKING, ICE SOLID INTERFACE, METAL ICE FRICTION, ICE MODELS, TEST CHAMBERS, ANALYSIS (MATHEMATICS).
A dimensional analysis of the problem of vessels transiting level continuous ice is presented. Resistance is divided into components and each is analyzed to identify dimensionless terms relevant to the individual component. These expressions provide a framework for scaling ship-ice model test results. A workable subset of scaling requirements for a three-component division of the problem is derived from the general case. Some experimental results are presented demonstrating the utility of the method. It is shown that it may be possible to compensate for poor scaling in ice properties by scaling each component based on its own law of similitude.

MP 2973
SEA ICE RIDGING IN THE EASTERN WEDDELL SEA.
Lytle, V.I., et al, *Journal of geophysical research,* Oct. 15, 1991, 96(C10), p.18,411-18,416, 17 refs.
Ackley, S.F.
46-1034
SEA ICE, ICE COVER THICKNESS, PRESSURE RIDGES, HEIGHT FINDING, ACOUSTIC MEASUREMENT, OCEANOGRAPHIC SURVEYS, ICE DEFORMATION, SOUNDING, STATISTICAL ANALYSIS, ANTARCTICA—WEDDELL SEA.
Sea ice ridge heights and spatial frequency in the eastern Weddell Sea were measured in 1986 using a ship-based acoustical sounder. Using a minimum ridge sail height of 0.75 m, a total of 933 ridges were measured along a track length of 415 km. The ridge frequency varied from 0.4 to 10.5 ridges/km. The mean height of the ridges was found to be about 1.1 m regardless of the ridge frequency. These results are compared to other ridging statistics from the Ross Sea and found to be similar. Comparison with arctic data, however, indicates that the height and frequency of the ridges are considerably less in the Weddell Sea than in the Arctic. Whereas in the Arctic the mean ridge height tends to increase with the ridge frequency, this was not the case in the Weddell Sea, where the mean ridge height remained constant irrespective of the ridge frequency. Estimates of the contribution of deformed ice to the total ice thickness are generally low, except for a single 53 km section where the ridge frequency increased by an order of magnitude. This resulted in an increase in the equivalent mean ice thickness due to ridging from 0.04 m in the less deformed areas to 0.45 m in the highly deformed section. These values were found to be consistent with values obtained from drilled profile lines during the same cruise. (Auth. mod.)

MP 2974
IS THE STRENGTH OF SEA ICE RELATED TO ITS CHLOROPHYLL CONTENT.
Eicken, H., et al, *Polar biology,* Sep. 1991, 11(5), p.347-350, 18 refs.
Ackley, S.F., Richter-Menge, J.A., Lange, M.A.
46-1073
ICE COMPOSITION, ICE COVER STRENGTH, ICE DENSITY, SEA ICE, ALGAE, SEASONAL ABLATION, ANTARCTICA—WEDDELL SEA.
Results of uniaxial compression tests are compared to porosity and chlorophyll content of granular sea-ice samples, collected in the Weddell Sea from June to Nov. of 1986. Compressive failure stresses are significantly correlated with the total porosity of the ice, but exhibit no correlation with chlorophyll concentration. It is suggested that high chlorophyll concentrations may accompany low ice strengths only because high porosities, which are responsible for low mechanical strength, can be linked to sea-ice biology. High concentrations of ice algae may be either cause or effect of high porosities (through absorption of solar radiation in the first case or due to enhanced nutrient supply and environmental space in the second case). As a cause of high porosities, ice organisms could therefore indirectly influence the spring break-up of floes and thus the course of the ablation season. (Auth.)

MP 2975
TIME CONSTANTS FOR THE EVOLUTION OF SEA SPRAY DROPLETS.
Andreas, E.L., *Tellus,* Nov. 1990, 42B(5), p.481-497, 56 refs. For another version see 44-1221.
46-1318
SEA SPRAY, AIR WATER INTERACTIONS, HEAT TRANSFER, MOISTURE TRANSFER, DROPS (LIQUIDS), MATHEMATICAL MODELS.
Sea spray droplets start with the same temperature as the ocean surface from which they form. In high-latitude, polar-low conditions, they therefore cool and evaporate in a relatively cold wind and may alter the air-sea exchange of heat and moisture. This paper presents equations that model the thermal and size (moisture) evolution of a spray droplet from the time it forms until it reaches equilibrium with its environment. The time required for a droplet to reach its equilibrium radius is always about three orders of magnitude larger than the time required to reach its equilibrium temperature. The thermal exchange is thus complete before the moisture exchange even starts. Consequently, the ambient humidity has little effect on the thermal exchange rate, and the initial droplet temperature has negligible effect on the moisture exchange rate. Spray droplets with initial radii less than 10 microns reach both thermal and size equilibrium with the ambient air. Droplets with initial radii greater than 300 microns fall back into the sea before exchanging appreciable heat or moisture and thus have little impact on air-sea exchange. Future work must focus on the generation and turbulent transport of droplets with initial radii between 10 and 300 microns if we are able to understand how sea spray affects air-sea exchange.

MP 2976
INTEGRATING REMOTELY SENSED AND SPATIAL DATA INTO WATER RESOURCES MODELS.
Merry, C.J., et al, Arnhem, Netherlands, International Association of Hydrogeologists (IAH), [1990], 8p., 10 refs. Presented at the International Symposium on Remote Sensing of Water Resources.
McKim, H.L.
46-1319
HYDROLOGY, WATER RESERVES, WATER BALANCE, REMOTE SENSING, DATA PROCESSING.
The U.S. Army Corps of Engineers is developing an intelligent network system that will automate the acquisition of meteorologic and hydrologic data used in water resources models. The system is being developed to collect, analyze, and display the data for use in a workstation environment. Near-real-time models will be used to control the water resources to protect the environment. As a result, spatial database management and remote sensing techniques play an integral part in the hydrologic modelling process.

MP 2977
COSMIC SPHERULES IN THE GEOLOGIC RECORD.
Taylor, S., et al, *Meteoritics,* 1991, Vol.26, p.203-211, 28 refs.
Brownlee, D.E.
46-1418
COSMIC DUST, CLASSIFICATIONS, GEOLOGICAL SURVEYS, AGE DETERMINATION, WEATHERING, CHEMICAL COMPOSITION, ICE SURVEYS, SPHERES, TIME FACTOR.

MP 2978
ICE-STRUCTURE INTERACTION DURING INDENTATION TESTS.
Nakazawa, N., et al, International Symposium on Okhotsk Sea and Sea Ice, 6th, Mombetsu, Hokkaido, Japan, Feb. 3-6, 1991. Abstracts, Mombetsu, Hokkaido University, Okhotsk Sea and Cold Ocean Research Association, 1991, p.107-111, 3 refs.
Sodhi, D.S.
46-1450
ICE COVER STRENGTH, ICE LOADS, ICE SOLID INTERFACE, ICE PRESSURE, IMPACT TESTS, PENETRATION TESTS, ICE BREAKING.

MP 2979
SELECTED PAPERS ON TURBULENCE IN A REFRACTIVE MEDIUM.
Andreas, E.L., ed, SPIE milestone series, Vol.MS 25, Bellingham, WA, International Society for Optical Engineering, 1990, 693p., Refs. passim. For selected papers see 42-3000 and 43-4400.
46-1481
ATMOSPHERIC PHYSICS, TURBULENCE, SCINTILLATION, BOUNDARY LAYER, WAVE PROPAGATION, OPTICAL PROPERTIES, REFRACTIVITY, ATMOSPHERIC ATTENUATION.

MP 2980
APPLICATION OF LOCAL SIMILARITY METHOD TO NONSIMILAR CONDUCTION CONTROLLED FREEZING PROBLEMS.
Aziz, A., et al, *International communications in heat and mass transfer,* Nov.-Dec. 1991, 18(6), p.813-822, 10 refs.
Lunardini, V.J.
46-1584
FREEZING, ANALYSIS (MATHEMATICS), PHASE TRANSFORMATIONS, LIQUID SOLID INTERFACES, HEAT TRANSFER, FREEZING FRONT, ACCURACY.
In this paper, the local method is used to solve three nonsimilar conduction controlled freezing problems. These are: (1) freezing of a semi-infinite medium with wall convection, (2) outward cylindrical freezing with constant wall temperature, and (3) freezing of a semi-infinite medium with time-dependent wall temperature. The local similarity solutions are compared to the heat balance integral, perturbation, coupled integral equation, and numerical solutions. The method is found to be accurate within a few percent.

MP 2981
PILOT-SCALE STUDIES OF SLUDGE DEWATERING IN A FREEZING BED.
Martel, C.J., et al, *Canadian journal of civil engineering,* Aug. 1991, 18(4), p.681-689, With French summary. 14 refs. For another version see 45-3738.
Diener, C.J.
46-1635
WASTE TREATMENT, SLUDGES, STRUCTURES, DESIGN, DRYING, FREEZE THAW TESTS, COLD WEATHER PERFORMANCE, CLIMATIC FACTORS, MELTWATER.
In 1986, a pilot-scale sludge freezing bed was constructed at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH, USA. This bed was operated for the next three years using both anaerobically and aerobically digested sludges. Results indicate that both sludges were effectively dewatered by this process. The maximum depth of sludge frozen during this study was 1.14 m. The final solid contents were 39.3% and 24.5% for anaerobically digested and aerobically digested sludges respectively. The quality of the meltwater from the bed was similar to raw wastewater. The actual depth of sludge frozen and thawed in the bed during each year of operation was very close to that predicted by design models. Operational experience demonstrated the importance of a sand layer at the bottom of the bed for adequate drainage. Also, odors developed when the meltwater was allowed to accumulate in the bed. Odors were not a problem when the meltwater was drained away as quickly as it formed. Both sludges were easily removed with a front-end loader.

MP 2982
ARCTIC RESEARCH OF THE UNITED STATES, VOL.5.
U.S. Interagency Arctic Research Policy Committee, Washington, D.C., Fall 1991, 78p., Refs. passim.
Myers, C.E., ed, Bowen, S., ed, Cate, D.W., ed, Valliere, D.R., ed.
46-1678
RESEARCH PROJECTS, ORGANIZATIONS, LEGISLATION, INTERNATIONAL COOPERATION, MEETINGS.

MP 2983
ONE-DIMENSIONAL MODEL FOR WAVE-INDUCED ICE-FLOE COLLISIONS.
Shen, H.H., et al, *Annals of glaciology,* 1991, Vol.15, Symposium on Ice-Ocean Dynamics and Mechanics, Hanover, NH, Aug. 26-31, 1990. Proceedings, p.87-95, 7 refs.
Ackley, S.F.
46-1716
ICE FLOES, ICE MECHANICS, DRIFT, ICE WATER INTERFACE, OCEAN WAVES, ICE GROWTH, ICE MODELS, MATHEMATICAL MODELS, WAVE PROPAGATION.
From observations made in the 1986 Winter Weddell Sea Project, the characteristics of ice floes and the formation process are described. The collision of ice floes under the action of a monotonic wave is quantified. The lateral motion of an ice floe caused by the wave is modeled as the sliding of an object under gravity. Drag and added mass effects are included in the model. Two floes located at different positions are shown to have a net difference in their drift (caused only by repeated wave passages). In most cases, this differential drift eventually causes floe collision. When two floes collide, a spring and dash-pot model is adopted to calculate the contact force. A one-dimensional wave passing through a one-dimensional array of disc-shaped floes is examined. Two phenomena are apparent from the analysis: waves have a herding effect that forms bands of floes with the width equal to the wavelength, and the frequency of collision is sensitive to the elastic properties of the floes and the wave amplitude. The floes stay in contact for prolonged periods, indicating the potential to freeze together and form composite floes, as was observed in the field studies. (Auth. mod.)

MP 2984
ENERGY EXCHANGES DURING INDENTATION TESTS IN FRESH-WATER ICE.
Sodhi, D.S., *Annals of glaciology,* 1991, Vol.15, Symposium on Ice-Ocean Dynamics and Mechanics, Hanover, NH, Aug. 26-31, 1990. Proceedings, p.247-253, 10 refs.
46-1740
ICE SOLID INTERFACE, ICE DEFORMATION, ICE LOADS, ICE PRESSURE, OFFSHORE STRUCTURES, ICE COVER STRENGTH, VIBRATION, IMPACT TESTS.
The data from a small-scale experimental study on ice-structure interaction are used to compute the energy exchanges that take place during creep deformation and intermittent and continuous crushing of ice. The energy supplied by the carriage is partly stored in the structural spring, partly dissipated as heat in the damping mechanisms of the structure. Except for the heat dissipation, all other forms of energy were computed from the experimental data, and the heat dissipation was computed from the energy balance using the first law of thermodynamics. Plots of all forms of energy are shown in graphical form, in which their relative magnitudes, times of occurrence and interplay can be seen. The main result of this study is the thesis that intermittent crushing or ice-induced vibration takes place whenever there is an imbalance between the rates of work done by the carriage and the indentor, and that there are no vibrations when these rates of work are equal.

MP 2985
ON THE RELATIONSHIP BETWEEN LOCAL STRESSES AND STRAINS IN ARCTIC PACK ICE.
Tucker, W.B., et al, *Annals of glaciology,* 1991, Vol.15, Symposium on Ice-Ocean Dynamics and Mechanics, Hanover, NH, Aug. 26-31, 1990. Proceedings, p.265-270, 15 refs.
Perovich, D.K., Hopkins, M.A., Hibler, W.D., III.
46-1743
PACK ICE, DRIFT, ICE PRESSURE, ICE COVER STRENGTH, ICE DEFORMATION, ICE NAVIGATION, ICE LOADS, PRESSURE RIDGES, NORWAY—SPITSBERGEN.
Local ice strains and *in situ* ice stresses were simultaneously measured on the Coordinated Eastern Arctic Experiment (CEAREX). The experiment took place in the fall of 1988 and was centered about an ice-strengthened ship moored to a multi-year floe in the pack ice northeast of Spitsbergen. Stress sensors were placed at four sites, two sites on each of two adjacent multi-year floes. Principal stress components and the principal stress direction were determined at each sensor. At the same time, microwave transponders capable of measuring ice deformation to accuracies of better than 1 m were positioned within 1 km of the stress sensors and provided an approximation of the local strain field. What makes this joint dataset particularly interesting is that it includes some large ridging events, including a particularly large event which terminated the experiment when the multi-year floes in the local area were broken into small fragments. A wide range of ice stresses was measured during the period. The largest compressive stresses, about 250 kPa, were measured by the near-surface sensors. Although sensors in different locations responded differently to ice movement, the large events were common to all shallow sensors.

MP 2986
NUTRIENT STATUS IN SEA ICE OF THE WEDDELL SEA DURING WINTER: EFFECTS OF SEA ICE TEXTURE AND ALGAE.
Dieckmann, G.S., et al, *Polar biology,* Dec. 1991, 11(7), p.449-456, Refs. p.455-456.
Lange, M.A., Ackley, S.F., Jennings, J.C., Jr.
46-1745
SEA ICE, ICE COMPOSITION, BIOMASS, ALGAE, ICE SALINITY, SALT WATER, ANTARCTICA—WEDDELL SEA.
Cores and brine samples from sea ice of the Weddell Sea were analyzed for nutrients (phosphate, nitrate and silicate), salinity and chlorophyll *a* during winter. Stratigraphic analyses of the cores were also carried out. Bulk nutrient concentrations in the sea ice fluctuated widely and did not correlate with salinity; they varied between zero and two or three times those measured in the water column. Differentiation into young and old sea ice, however, revealed that nutrient concentrations in the young sea ice in many cases correspond to those in surface seawater. In older ice, nutrients showed signs of increase as well as depletion or exhaustion relative to the water column. Most of the changes in the nutrient concentrations are attributed to an increase in biological activity as the seasons progress. Silicate is expected to become the first nutrient likely to limit growth of diatoms in the ice, which is ascribed to slower regeneration or dissolution of this nutrient relative to phosphate and nitrate. A consequence of silicate exhaustion may be the succession of different algal assemblages, from a diatom-dominated community to one in which autotrophic flagellates form the largest component. (Auth. mod.)

MP 2987
ADMIXTURES FOR COLD WEATHER CONCRETING.
Korhonen, C.J., *American Public Works Association. APWA reporter,* Jan. 1992, 59(1), p.24.
46-1860
WINTER CONCRETING, ANTIFREEZES, CONCRETE ADMIXTURES.

MP 2988
FINITE ELEMENT TECHNIQUE FOR THREE-DIMENSIONAL FREEZE-THAW PREDICTION.
McGilvary, W.R., et al, International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.99-116, 14 refs.
Albert, M.R.
46-1815
PHASE TRANSFORMATIONS, LIQUID SOLID INTERFACES, HEAT TRANSFER, CONDUCTION, FREEZING FRONT, GROUND THAWING, MATHEMATICAL MODELS.
Heat conduction with phase change characterizes many problems in cold regions heat transfer. The analysis of practical, multi-dimensional problems is made challenging because of the moving phase-change interface, the difference in thermal properties between frozen and thawed phases, mixed boundary conditions, various heat sources, and complex geometry. The finite element technique has thus far been used successfully to analyze two-dimensional problems. In the current work,

O'Neill's method of simulating phase change in two dimensions is extended to three dimensions. Phase change occurs at a discrete temperature and is implemented via a Dirac delta function. For cases where the elemental volume becomes isothermal at the phase change temperature, a so-called mushy region, a variation of O'Neill's method is presented. Included in the model are typical boundary conditions and source terms that may be useful to analyze both passive and active arctic foundations, thaw degradation around a borehole, stabilization of road embankments, or phase-change heat storage devices.

MP 2989

FINITE DIFFERENCES WITH SINGULAR HEAT CAPACITY AND STABILITY CONSIDERATIONS FOR PHASE CHANGE COMPUTATION.

O'Neill, K., International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.117-133, 25 refs.

46-1816

PHASE TRANSFORMATIONS, HEAT TRANSFER, LIQUID SOLID INTERFACES, HEAT CAPACITY, BOUNDARY VALUE PROBLEMS, FREEZING FRONT, ANALYSIS (MATHEMATICS).

It has been shown in previous work with finite elements that one can account for phase change latent heat effects computationally by embedded a singularity ("delta function") in the heat capacity. Normal finite element procedures then evaluate the apparent heat capacity (AHC) exactly, and computed results have been good. In this paper it is shown that the same methodology can be generalized to include a finite difference formulation which also works well. In addition, as a first attempt at rational stability analysis of the numerical phase change problem, simple representative 1-D cases are considered in the framework of a moving boundary formulation. The analysis produces distinct and sometimes counter-intuitive stability criteria relating simultaneously to the time stepping solution and the embedded iteration system for dealing with the nonlinearity. Results are borne out in numerical tests, and may furnish stability guidance for more general moving-boundary type phase change calculation. At least in the simple test cases investigated, the AHC system outlined above is not restricted by the stability bounds applicable to the moving boundary formulation.

MP 2990

REVIEW OF INTRINSIC THERMOPHYSICAL PROPERTIES OF SNOW, ICE, SEA ICE, AND FROST.

Yen, Y.C., et al, International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.187-218, 91 refs.

Cheng, K.C., Fukusako, S.

46-1822

ICE THERMAL PROPERTIES, SNOW THERMAL PROPERTIES, ICING, HEAT TRANSFER, THERMAL CONDUCTIVITY, SPECIFIC HEAT, LATENT HEAT, ICE DENSITY, THERMAL EXPANSION, ANALYSIS (MATHEMATICS).

This paper reviews the intrinsic thermophysical properties of snow, ice, sea ice and frost. The subjects of density, thermal expansion and compressibility of ice are discussed. In addition, the absorption coefficient of ice along with the heat capacity, latent heat of fusion and thermal conductivity of snow and ice are summarized. These topics are analyzed over a wide range of temperatures and, in the case of snow and frost, the effect of density is evaluated. The contributions of vapor diffusion and radiative and free convective heat transfer across the pore space are assessed in relation to the overall effective thermal conductivity of snow and frost. Frost layer growth rate and thickness as functions of air velocity, temperature and humidity, cooling plate surface temperature and time are also discussed. Expressions representing the specific and latent heat of sea ice in terms of salinity and temperature are given, and theoretical models to predict the thermal conductivities of fresh bubbly ice and sea ice as functions of salinity, temperature and air content are also derived.

MP 2991

ON THE ONSET OF CONVECTION OF WATER NEAR 4 C.

Yen, Y.C., International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.455-470, 480, 12 refs.

46-1844

HEAT TRANSFER, CONVECTION, ICE WATER INTERFACE, WATER FLOW, WATER STRUCTURE, HYDRODYNAMICS, TEMPERATURE EFFECTS, WATER TEMPERATURE, ANALYSIS (MATHEMATICS).

Natural convection heat transfer has been studied extensively, both experimentally and analytically, and the results have been well documented. However, nearly all the work reported has dealt with fluids having monotonic density-temperature relationships or with a temperature range that precludes a density inversion. Water possesses a density anomaly at about 4 C (3.98). Therefore, for either a single-phase layer containing 4 C water or a layer formed as a result of melting ice, the classical criterion of Rayleigh stability cannot be applied. This review summarizes the studies conducted since the early 1960s on the effect of this unique density inversion on the onset of convection in a number of geometrical configurations. It has been clearly demonstrated both analytically and experimentally that the critical Rayleigh number or the critical Grashof number for either a water or ice-water system is no longer a constant value, but varies with the imposed thermal and geometric conditions.

MP 2992

HEAT TRANSFER ASSOCIATED WITH CONVECTION AND VAPOR TRANSPORT IN DRY SNOW.

Albert, M.R., et al, International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.481-494, 19 refs.

McGilvary, W.R.

46-1846

SNOW AIR INTERFACE, SNOW HEAT FLUX, SNOW THERMAL PROPERTIES, HEAT TRANSFER, CONVECTION, VAPOR TRANSFER, AIR FLOW, SNOW PERMEABILITY, MATHEMATICAL MODELS.

The coupled heat and mass transfer problem of air flow through snow subject to an imposed temperature gradient is investigated numerically. A new method is proposed for the theoretical prediction of vapor transport, whereby the snow is not assumed to be saturated with vapor. Results are shown to compare favorably with analytical and experimental results. For forced convection with the set of experimental conditions examined here, it is demonstrated that the heat transfer associated with vapor transport is significant in the determination of the temperature profile, but that the major effect is due to heat convected by the dry air.

MP 2993

LOCAL SIMILARITY SOLUTION FOR FREEZING IN A SEMI-INFINITE MEDIUM WITH WALL CONVECTION.

Aziz, A., et al, International Symposium on Cold Regions Heat Transfer, 3rd, Fairbanks, AK, June 11-14, 1991. Proceedings. Edited by J.P. Zarling and S.L. Faussett, Fairbanks, University of Alaska, 1991, p.515-522, 11 refs.

Lunardini, V.J.

46-1849

PHASE TRANSFORMATIONS, HEAT TRANSFER, LIQUID SOLID INTERFACES, FREEZING FRONT, CONVECTION, BOUNDARY VALUE PROBLEMS, STEFAN PROBLEM, ANALYSIS (MATHEMATICS).

An instantaneous similarity solution is developed for the freezing of a semi-infinite extent of liquid initially at its freezing temperature and cooled by convection at the wall. The solution involves four parameters: pseudo similarity variable eta, dimensionless time A, freezing front parameter lambda, and Stefan number S. The transcendental equation relating eta, S and A is solved numerically and the results are presented in graphical form. The progress of the freezing front is displayed for S=0.1, 0.2, 0.5, 1.0, 2.0, and 3.0 These results are compared with the heat balance integral, perturbation, and analog solutions and found to be quite accurate. Results for the surface temperature history for S=0.5, 1, 5, and 10 also compare well with the corresponding heat balance integral results. The solution strategy appears to be potentially useful for other nonsimilar phase change problems.

MP 2994

WAVY ICE GROWTH IN FORCED FLOW.

Albert, M.R., San Diego, University of California, 1991, 97p., Ph.D. thesis. Refs. passim.

46-1854

ICE FORMATION, ICE GROWTH, ICE WATER INTERFACE, FLUID FLOW, TURBULENT FLOW, LAMINAR FLOW, PIPE FLOW, BOUNDARY VALUE PROBLEMS, ICE MODELS, MATHEMATICAL MODELS, ICE HEAT FLUX.

The goal of this work is to develop the analysis capability for predicting irregular and wavy ice formations in forced laminar and turbulent flow, and to use that capability in initial investigations in ice formation in internal flows such as in pipes or conduits. The stability of a small-amplitude perturbation of the ice interface in pipes is investigated, using analytical solutions for heat conduction in the ice and numerical solutions for heat transfer from the fluid. The analysis shows that, for small-amplitude perturbations and wavelengths up to sixty times the pipe diameter, heat transfer effects from the flow alone cannot cause the onset of instability. However, heat transfer from the ice in the cylindrical geometry of a pipe can have a destabilizing influence on ice growth. The destabilizing influence is most likely to occur during freezing, for thick ice and long wavelengths. Numerical experiments are conducted with the fully nonlinear moving boundary model in which both smooth ice and irregular ice profiles evolve. It is shown that the introduction of a numerical perturbation into a simulation involving initially flat ice and uniform boundary and inlet conditions can lead to a step ice profile and eventual flow recirculation. The step ice profile results from the turbulent heat transfer, and serves to illustrate the importance of including turbulence calculations in the flow field.

MP 2995

INVERSION OF AIRBORNE ELECTROMAGNETIC SURVEY DATA FOR SEA-ICE KEEL SHAPE.

Liu, G.M., et al, *Geophysics,* Dec. 1991, 56(12), p.1986-1991, 13 refs.

Kovacs, A., Becker, A.

46-1890

SEA ICE, ICE COVER THICKNESS, SOUNDING, ELECTROMAGNETIC PROSPECTING, AERIAL SURVEYS, ICE BOTTOM SURFACE, ACCURACY, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS).

It is possible to interpret conventional airborne electromagnetic (EM) data acquired over ice-covered arctic seas to obtain values of the sea ice thickness and, where needed, the actual sea ice keel geometry. To do so, high-frequency (inductive limit) data are required that permit the assumption that the ice is virtually transparent to the EM fields while the sea water forms a perfect conductor. Practically, a 100 kHz operating frequency is needed, but data acquired at a lower frequency can be scaled to obtain the required inductive limit anomaly. The data inversion is done by linking Occam's inversion method to a rapid numerical two-dimensional forward solution for the ice keel problem. Tests on synthetic data show a possible worst-case ice thickness error of about 15%. The results of inversion tests for two sets of survey data acquired near Prudhoe Bay, AK, also indicate an accuracy of this order. While some portion of the inversion error must be ascribed to the roughness constraint and is therefore inherent in the inversion technique used, the remainder must be ascribed to the instrumentation and is probably remediable.

MP 2996

SOUNDING SEA ICE THICKNESS USING A PORTABLE ELECTROMAGNETIC INDUCTION INSTRUMENT.

Kovacs, A., et al, *Geophysics,* Dec. 1991, 56(12), p.1992-1998, 12 refs. For another version see 46-717.

Morey, R.M.

46-1891

SEA ICE, ICE COVER THICKNESS, SOUNDING, ELECTROMAGNETIC PROSPECTING, PORTABLE EQUIPMENT, REMOTE SENSING, PERFORMANCE, ELECTRICAL RESISTIVITY.

Field trials using a man-portable, commercially available electromagnetic induction (EMI) sounding instrument, with a plug-in data processing module for the remote measurement of sea ice thickness, are discussed. The processing module was made to allow for the direct determination of sea ice thickness and to show the result in a numerical display. The processing module system was capable of estimating ice thickness within 10% of the true value for ice from about 0.7 to 3.5 m thick, the thickest of undeformed ice in the study area. However, since seawater under the arctic pack ice has a relatively uniform conductivity (2.55 +/- 0.05 S/m), a simplified method can be used for estimating sea ice thickness using just an EMI instrument. This technique uses only the EMI conductivity measurement, is easy to put into use, and does not rely on theoretically derived look-up tables or phasor diagrams, which may not be accurate for the conditions of the area.

MP 2997

THERMAL RESPONSE OF DOWNHILL SKIS.

Colbeck, S.C., et al, *Journal of glaciology,* 1991, 37(126), p.228-235, 12 refs.

Warren, G.C.

46-1896

SKIS, ICE SOLID INTERFACE, SLIDING, PLASTICS SNOW FRICTION, HEAT FLUX, TEMPERATURE MEASUREMENT, THERMAL CONDUCTIVITY, SURFACE TEMPERATURE, THERMAL ANALYSIS.

The temperatures in downhill skies were measured with thermocouples to investigate the heat generation associated with the sliding of skis on snow. In these tests the effects on ski temperature of the ambient snow temperature, snow type, speed, load and thermal conductivity were investigated. A significant temperature rise at the base of the ski was found at the onset of motion in all runs. The temperature rise increased for heavier loads and at lower ambient temperatures. Some ski runs lasted long enough to observe a steady-state temperature at the ski base; it increased with ambient temperature. Longitudinal and transverse temperature variations occurred and were sensitive to snow hardness and skiing technique. Also investigated was heat flow through the cross-section of the ski with a finite-element model to determine the effects of ski structure on heat retention at the base. The authors found that the thermal characteristics as determined by the structure of the ski had a significant effect on the temperature at the ski base. At lower temperatures it is expected that friction will be greater in skis which have a large aluminum plate across their base. Steel edges have a lesser effect.

MP 2998
ICEBERGS.
Ackley, S.F., Encyclopedia of earth system science, Vol.2. Edited by W.A. Nierenberg, San Diego, Academic Press, 1991, p.571-582, 11 refs.
46-1946
ICEBERGS, ORIGIN, DRIFT, ICEBERG TOWING.

Icebergs are the floating remnants of ice produced on the continents in glaciers, ice sheets, and ice shelves that originate as snow compressed into ice. They differ from sea ice, which also floats in the ocean in cold regions, in that sea ice is produced by the direct freezing of seawater. Icebergs are a unique part of the earth's hydrologic cycle. The cycle is initiated as oceanic evaporated moisture which is condensed, frozen, and deposited as snow precipitation on the continents and compressed into ice by a 100 m or so of overburden snow. The ice flows to the ocean in ice streams or glaciers that are driven by gravity and that densify and deform as the ice migrates (they behave as slowly moving rivers of ice). The cycle is completed by the ice breaking off into the sea as icebergs, which then melt slowly in the ocean. For the dominantly ice portion of the hydrologic cycle the time scales are typically from decades to thousands of years, compared with the annual or slightly longer time scales more typical of the water-based hydrologic cycle in lower latitudes. Icebergs in Antarctica, Greenland, Alaska, and other northern hemisphere regions are discussed in this article. (Auth.mod.)

MP 2999
SOIL WATER: LIQUID, VAPOR, AND ICE.
Black, P.B., Encyclopedia of earth system science, Vol.4. Edited by W.A. Nierenberg, San Diego, Academic Press, 1991, p.259-269, 4 refs.
46-1954
SOIL WATER, ADSORPTION, CAPILLARITY, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS).

MP 3000
PROCEEDINGS OF THE 48TH ANNUAL EASTERN SNOW CONFERENCE, GUELPH, ONTARIO, JUNE 5-7, 1991.
Eastern Snow Conference, 1991, 344p., Refs. passim. For individual papers see 46-1967 through 46-1998.
Ferrick, M., ed, Pangburn, T., ed.
46-1966
SNOW SURVEYS, SNOW COVER EFFECT, SNOW COVER DISTRIBUTION, SNOWMELT, SNOW COMPOSITION, SNOW WATER EQUIVALENT, RUNOFF, SNOW DEPTH, SNOWFALL, ICE COVER.

MP 3001
EFFECTS OF CRYSTAL METAMORPHOSIS ON THE ELUTION OF CHEMICAL SPECIES FROM SNOW.
Hewitt, A.D., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.1-10, 9 refs.
Cragin, J.H., Colbeck, S.C.
46-1967
METAMORPHISM (SNOW), SNOW COMPOSITION, SNOWMELT, WATER CHEMISTRY, SNOW CRYSTAL GROWTH, ION DENSITY (CONCENTRATION), SNOW IMPURITIES, CHEMICAL PROPERTIES.

Columns of fresh snow were aged in a -20 C coldroom with an imposed thermal gradient of approximately 36 C/m for periods of one to eight weeks. Deionized distilled water was then passed through a column of this aged snow and the eluate collected in sequential aliquots for determination of H+, Cl-, NO3- and SO4 2-. Concentrations of these ions in the eluate show that both fractionation (higher concentrations in initial aliquots) and preferential elution (greater enrichment of SO4 2- relative to Cl-) in melting snow are strongly influenced by snow metamorphic processes.

MP 3002
TERRAIN CLASSIFICATION OF SNOW-COVERED WATERSHEDS.
Elder, K., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.39-49, 17 refs.
Davis, R.E., Bales, R.C.
46-1970
TERRAIN IDENTIFICATION, SNOW COVER DISTRIBUTION, WATERSHEDS, SNOW SURVEYS, SNOW WATER EQUIVALENT, SNOWMELT, RUNOFF FORECASTING, TOPOGRAPHIC EFFECTS, ALPINE LANDSCAPES, MATHEMATICAL MODELS.

If the spatial distribution of snow can be estimated, it may be classified into areas, which may simplify snow melt calculations, melt water routing through the pack, and recovery of snow properties from remote sensing data. Complex topography produces spatially variable patterns of snow accumulation and ablation. The objective in this study is to develop an automated method that unambiguously divides a snow-covered watershed into terrain units that: 1) do not overlap major subcatchment divides, 2) have similar net potential solar radiation within their boundaries, and 3) have relatively uniform snow water equivalence within their boundaries. It is shown that the number of classes delineated by this method will be orders of magnitude less than the number of nodes in a digital elevation model of even a small watershed, which can be on the order of 100,000 to 1,000,000. This method is developed in an alpine watershed whose landcover features are simple; it has little vegetation or soil cover. The method is suitable to distribute point energy balance calculations over a watershed.

MP 3003
MICROWAVE PROPAGATION OVER A CHANGING SNOWCOVER.
Peck, L., *Eastern Snow Conference. Proceedings,* 1991, 48th, p.163-174, 4 refs.
46-1979
SNOW COVER EFFECT, SNOW ELECTRICAL PROPERTIES, MICROWAVES, SNOW SURFACE, RADAR, WAVE PROPAGATION.

A bistatic (separate transmit and receive units) microwave (10.5 GHz) radar is in continuous operation over a 120 m range at the CRREL research facility in South Royalton, VT. The transmitting and receiving antennas, mounted at a height of 60 cm over level, grass-covered ground, have E-plane vertical polarization and a 3.5-degree single-lobe pattern. The microwave carrier is modulated at 3 kHz. The microwave field at the receiver consists of directly transmitted, reflected, and scattered radiation. Variation in the received microwave field is monitored as a voltage proportional to field strength (automatic gain control, AGC). The instantaneous AGC voltage is reported to a recording system every half hour, together with automated snow depth and site meteorology data. The AGC is seen to increase during snowfall and to decrease as the depth of the snowcover decreases. During periods of approximately constant snow depth, the AGC fluctuates with the (inferred) moisture content of the snow. For a given snow depth, the microwave field strength at the receiver is weaker, evident as a larger AGC, when the microwaves have propagated over a relatively wetter snow cover. The propagation loss over moist ground, as following snowmelt or thawing of the soil, is lower than that over dry, frozen soil.

MP 3004
MULTIDIMENSIONAL OBSERVATION OF SNOW TEMPERATURE ON WINDY DAYS.
Albert, M.R., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.189-200, 4 refs.
McGilvary, W.R.
46-1981
SNOW AIR INTERFACE, SNOW TEMPERATURE, WIND FACTORS, AIR FLOW, SNOW HEAT FLUX.

Three-dimensional field measurements of snow temperature in a shallow, seasonal snowpack were made during the winter of 1990-1991. The data show evidence of the thermal effects of windpumping down to depths of approximately 12 cm in a seasonal snow cover of 23 cm total depth. The air movement through the snow tends to decrease the local temperature gradient in the upper portion of the snowpack over the gradient that exists in windless conditions.

MP 3005
SHIP SUPERSTRUCTURE ICING CLIMATOLOGY OF COASTAL EASTERN NORTH AMERICA.
Ryerson, C.C., *Eastern Snow Conference. Proceedings,* 1991, 48th, p.201-211, 21 refs.
46-1982
SHIP ICING, CLIMATIC FACTORS, SYNOPTIC METEOROLOGY, ICE FORECASTING, SUPERSTRUCTURES, FRONTS (METEOROLOGY), STATISTICAL ANALYSIS.

Superstructure icing occurs when bow-generated spray freezes on decks and bulkheads. Most common to smaller vessels, icing hinders deck activity, increases draft, decreases freeboard, and raises center of gravity. Forecasts of icing potential may allow vessels to avoid hazardous areas. This report develops a synoptic climatology of superstructure icing in eastern North American coastal waters from a database maintained by the Atmospheric Environment Service of Canada. Ships with 5 cm or more of accreted ice were selected from the database, providing a sample of 117 superstructure icing incidents. Eighty percent of cases occurred behind cold fronts, with a mean distance behind cold fronts of 1600 km. Mean distances of cases from the nearest closed low are about 1000 km. Ship headings during icing are typically into the true wind in low to moderate sea states, with air temperatures averaging -8 C. Synoptic patterns found in this sample of ship icing cases are similar to those of other east coast Northern Hemisphere locations investigated by the Soviets and Japanese.

MP 3006
SNOW AS AN EXPEDIENT ADSORBENT FOR HAZARDOUS WASTE SPILLS.
Martel, C.J., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.213-220, 7 refs.
Nadeau, B.M.
46-1983
SNOW COVER EFFECT, SNOW SURFACE, OIL SPILLS, WASTE DISPOSAL, ADSORPTION, OIL RECOVERY, SNOW PERMEABILITY, SCAVENGING.

Laboratory tests indicate that snow can be an effective adsorbent for spills of insoluble hazardous waste materials. Fresh snow was most effective, followed by old snow and wet snow. The sorption ratios ranged from 0.24 g/g to 3.12 g/g depending on the type of snow and waste material. Also, a column study indicated that much of the adsorbed material drains out if it is not collected soon after it is mixed with the snow. A hypothetical spill scenario is presented that shows how snow might be used as an adsorbent in a typical spill situation.

MP 3007
HIGH LATITUDE, WEST COAST MOUNTAINTOP ICING.
Claffey, K.J., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.221-232, 9 refs.
Ryerson, C.C.
46-1984
ICING, ICE STORMS, ICE DETECTION, ICING RATE, ICE ACCRETION, MOUNTAINS.

Numerous studies have characterized in-cloud mountaintop icing at North American midlatitude locations. This paper describes mountaintop icing at a high-latitude west coast location, Site Summit, near Anchorage, AK. Icing was monitored at an elevation of 1189 m with a Rosemount ice detector. Data from the 1989-90 winter season at Site Summit are compared to icing conditions at two east coast sites. Site Summit had 102 icing events during the year with an average duration of 7.5 hours per event. Peak icing intensity occurred in the late fall and early winter, with icing rates averaging 0.11 g/hr-cm of ice detector probe length and peaking at 1.06 g/hr-cm of probe length. An overview of weather conditions during icing events is also presented from measurements from nearby rawinsondes.

MP 3008
INVESTIGATION OF TEMPERATURE VARIATION OVER SNOW-COVERED GROUND.
Hogan, A.W., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.245-254, 17 refs.
Ferrick, M.
46-1986
SNOW AIR INTERFACE, SNOW COVER EFFECT, SURFACE TEMPERATURE, AIR TEMPERATURE, TEMPERATURE VARIATIONS, TEMPERATURE INVERSIONS.

Fragmentary climatic data show that large mean winter temperature differences occur over short horizontal distances in northern New England. Initial winter experiments indicated that very great local variation in pre-sunrise surface air temperature occurred along the Connecticut Valley. A thin layer of air over or adjacent to the Connecticut River was proposed as a reference plane to examine these temperature differences. Experiments showed this reference plane concept to be valid over a 10 km distance scale, but that nonuniform cloud cover often invalidated the reference plane concept on a 30 km distance scale. The influences of slope and terrain on local temperature structure are presented, showing that temperatures on small flats and in small basins differ the most from general tropospheric temperatures. The greatest local air temperature differences with respect to both time and space occur during periods of warm advection, and somewhat lesser variation occurs during cold zonal advection. The least local temperature differences occur during cold meridional advection.

MP 3009
HIGH-WIND SNOW COLLECTOR.
Govoni, J.W., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.281-284, 3 refs.
Meese, D.A.
46-1990
BLOWING SNOW, SNOW COMPOSITION, METEOROLOGICAL INSTRUMENTS.

Pure snow samples that are free from local contaminants can best be collected on mountaintops, but the extremely high winds that typically occur there make sample collection difficult. During the winters of 1989-90 and 1990-91, snow samples were collected at the summit of Mt. Washington, NH, using a specially designed high-wind snow collector that allowed snow collection in winds as high as 80 mph (129 km/h) and temperatures as low as 0 F (-18 C). The collector consists of a Lexan "bucket" and an adjustable framework that allows the bucket to be rotated directly into the wind for increased collection efficiency.

MP 3010
SNOW, ICE AND FROZEN GROUND OBSERVATIONS IN A POND/MARSH WETLAND.
Melloh, R.A., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.285-292, 8 refs.
Racine, C.H.
46-1991
WETLANDS, FROST PENETRATION, ICE COVER THICKNESS, PONDS, SNOW COVER EFFECT, HEAT FLUX, MOISTURE TRANSFER.

MP 3011
PRECISE WATER TEMPERATURE MEASUREMENT AT REMOTE FIELD SITES.
Clark, C., et al, *Eastern Snow Conference. Proceedings,* 1991, 48th, p.301-306, 1 ref.
Daly, S.F., Rand, J.
46-1993
WATER TEMPERATURE, TEMPERATURE MEASUREMENT, THERMISTORS, PROBES, DATA TRANSMISSION.

An instrument developed at USACRREL to precisely measure water temperature at field sites consists of a temperature probe, connecting cabling and an interface box; it is rugged, highly accurate and easily deployable. The probes contain individually calibrated thermistors, whose resistance is determined by voltage measurements of a half-bridge circuit in the interface box. A precision 10K ohm resistor in the interface box helps assess the accuracy of the voltage measurements, and provides a means of correcting the thermistor readings. Generally, the temperature probe is connected to a Data Collection Platform (DCP) and the readings are transmitted through a Geostationary Operational Environmental Satellite (GOES) to a downlink. Such probes are installed on the St. Clair, the St. Lawrence, the Ohio, the Missouri and the Illinois rivers. They are adaptable to a variety of site conditions, and can be strapped to vertical walls or deployed horizontally through gage well connecting pipes.

MP 3012
SIMPLE MODEL OF SHOCK-WAVE ATTENUATION IN SNOW.
Johnson, J.B., *Journal of glaciology,* 1991, 37(127), p.303-312, 12 refs.
46-2155
SNOW COVER EFFECT, SNOW COMPACTION, SHOCK WAVES, WAVE PROPAGATION, ATTENUATION, EXPLOSION EFFECTS, SNOW MECHANICS, MATHEMATICAL MODELS.
A simple momentum model, assuming that snow compacts along a prescribed pressure-density curve, is used to calculate the pressure attenuation of shock waves in snow. Four shock-loading situations are examined: instantaneously applied pressure impulses for one-dimensional, cylindrical and spherical shock-wave geometries, and a one-dimensional pressure impulse of finite duration. Calculations show that for an instantaneously applied impulse the pressure attenuation for one-dimensional, cylindrical and spherical shock waves is determined by the pressure density compaction curve of snow. The shock-wave pressure in snow for a finite-duration pressure impulse is determined by the pressure impulse versus time profile during the time interval of the impulse. After the pressure impulse ends, shock-wave pressure attenuation is the same as for an instantaneously applied pressure impulse containing the same total momentum. Pressure attenuation near a shock-wave source, where the duration of the shock wave is relatively short, is greater than for a shock wave farther from a source where the shock wave has a relatively long duration. Shock- wave attenuation in snow can be delayed or reduced by increasing the duration of a finite-duration pressure impulse. A sufficiently long-duration impulse may result in no shock-wave pressure attenuation in a shallow snow cover.

MP 3013
NON-CLIMATIC CONTROL OF GLACIER-TERMINUS FLUCTUATIONS IN THE WRANGELL AND CHUGACH MOUNTAINS, ALASKA, U.S.A.
Sturm, M., et al, *Journal of glaciology,* 1991, 37(127), p.348-356, 49 refs.
Hall, D.K., Benson, C.S., Field, W.O.
46-2161
GLACIER OSCILLATION, GLACIER TONGUES, GLACIER SURVEYS, GLACIER FLOW, VOLCANOES, TIDAL CURRENTS, MELTWATER, RUNOFF, PERIODIC VARIATIONS, UNITED STATES—ALASKA—WRANGELL MOUNTAINS.
Fluctuations of glacier termini were studied in two regions in Alaska. In the Wrangell Mountains, 15 glaciers on Mount Wrangell, an active volcano, have been monitored over the past 30 years by surveying, photogrammetry and satellite. Results, which are consistent between different methods of measurement, indicate that the termini of most glaciers were stationary or retreating slightly. The terminus fluctuations of six tide-water and near- tide-water glaciers in College Fjord, Prince William Sound, have also been monitored since 1931 by surveying, photogrammetry and, most recently, by satellite imagery. Harvard Glacier, a 40 km long tide-water glacier, has been advancing at an average rate of nearly 20 m/yr since 1931, while the adjacent Yale Glacier has retreated at approximately 50 m/yr during the same period though, for short periods, both of these rates have been much higher. The striking contrast between the terminus behavior of Yale and Harvard Glaciers, which parallel each other in the same fjord, and are derived from the same snowfield, supports the hypothesis that their terminus behavior is largely the result of dynamic controls rather than changes in climate.

MP 3014
GLACIOLOGY AND ICING ON STRUCTURES.
Itagaki, K., International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90, Tokyo, 1990, p.A0/2/1-A0/2/6, 12 refs.
46-2194
ICING, ICE ACCRETION, ICE ADHESION, ICE SOLID INTERFACE, SNOW CRYSTALS, SNOW REMOVAL.
Various aspects of the problems involved in atmospheric icing and ice adhesion are discussed. In this paper examples are given of hidden and unexpected mechanisms that may play an important role in ice adhesion.

MP 3015
MEASUREMENT OF RELATIVE HUMIDITY IN CLOUDS.
Itagaki, K., et al, International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90, Tokyo, 1990, p.A1/1/1-A1/1/4, 5 refs.
Lemieux, G.E.
46-2196
HUMIDITY, CLOUD DROPLETS, CLOUD PHYSICS, ICING, DEW POINT, HYGROMETERS.
Attempts were made to determine if relative humidity (RH) between cloud droplets may be below water saturation when extensive ice particles are present. RH and temperature measurements behind a cylindrical shield were compared with in-stream measurements. Dew point measurements under certain conditions were more than 1 C lower behind the shield than in the stream, which indicates that RH is 10% below the water saturation at that temperature.

MP 3016
AERODYNAMIC PROPERTIES OF NATURAL RIME ICE SAMPLES.
Jones, K.F., et al, International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90, Tokyo, 1990, p.A5/1/1-A5/1/6, 10 refs.
Govoni, J.W.
46-2221
ICING, ICE LOADS, WIND PRESSURE, ICE AIR INTERFACE, ICE ACCRETION, ICE SURFACE, SURFACE ROUGHNESS.
Natural rime ice samples were collected on Mt. Washington on rods placed at the midsection of a diagonally oriented taut cable. Two rod samples were collected simultaneously on parallel cables. One of each pair was tested in the refrigerated wind tunnel at the University of Quebec at Chicoutimi to measure the lift and drag on the sample at different wind speeds. The second sample in the pair was used to determine the ice properties associated with the measured lift and drag. It was cut into slices whose mass and thickness were measured. The slices were photographed under crossed polarizers on a 1 cm grid, and the photographs were analyzed using a PC-based image processor to obtain the cross- sectional area and the rime surface topography. From these data the average sample density was determined and the surface roughness was characterized. The relationships among the icing conditions, ice density, roughness and wind loading were investigated.

MP 3017
UNIVERSAL FLYING PARTICLE CAMERA.
Itagaki, K., et al, International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90. Tokyo, 1990, p.B2/1/1-B2/1/4.
Ryerson, C.C.
46-2240
SEA SPRAY, METEOROLOGICAL INSTRUMENTS, PHOTOGRAPHIC EQUIPMENT, PARTICLE SIZE DISTRIBUTION, MEASURING INSTRUMENTS.
A simple system for optically capturing airborne precipitation was developed using off-the-shelf components: a video camera, a Strobo-Tac strobe light system and a video recorder. The system was mainly designed to capture sea spray on board a ship, and thus was weathertight and included defrosters, washers, and wipers. Two inclinometers were included to indicate optically the ship's rolling and pitching on image frames.

MP 3018
SEA SPRAY ICING RATES. I. INTERMITTENT SEA SPRAY.
Itagaki, K., International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90, Tokyo, 1990, p.B2/3/1-B2/3/7, 3 refs.
46-2241
SEA SPRAY, SHIP ICING, ICING RATE, COMPUTER PROGRAMS.
The icing rate by intermittent sea spray was studied using a computer model based on heat removal and water supply balanced with heat supply and water drainage. Three icing regimes, water supply controlled, mixed and melting, were identified. The maximum icing rate appeared at the lower side of water supply under the assumed conditions. Excessive water supply tended to reduce icing rate.

MP 3019
SEA SPRAY ICING RATES. II. CONTINUOUS SEA SPRAY.
Itagaki, K., International Workshop on Atmospheric Icing of Structures, 5th, Tokyo, Oct. 29-Nov. 1, 1990. IWAIS '90, Tokyo, 1990, p.B2/4/1-B2/4/8, 9 refs.
46-2242
SEA SPRAY, SHIP ICING, ICING RATE, COMPUTER PROGRAMS.
The rate of icing caused by continuous sea spray was examined using a model based on supply and balance of heat and water. The results were compared with on-board ship icing observations. At lower air temperature, the model could predict the rate of icing reasonably well, but at the higher temperatures heat removal by simple convective heat transfer was insufficient.

MP 3020
RIVER ICING MOUNDS: A WINTER WATER SOURCE ON THE EASTERN NORTH SLOPE OF ALASKA.
Chacho, E.F., Jr., et al, *Environment Canada. National Hydrology Research Institute. NHRI symposium,* 1991, No.6, Northern hydrology: selected perspectives. Edited by T.D. Prowse and C.S.L. Ommanney, p.33-45, 16 refs.
Collins, C.M., Delaney, A.J., Arcone, S.A.
46-2329
NALEDS, FROST MOUNDS, WATER SUPPLY, RIVER ICE, ICE COVER THICKNESS, ICE SURVEYS, UNFROZEN WATER CONTENT, WATER RESERVES, AIRBORNE RADAR, UNITED STATES—ALASKA—NORTH SLOPE.
The icing mounds on two eastern North Slope rivers, the Sadlerochit and Hulahula, were investigated in Apr. 1989. Approximately 100 mounds were surveyed on each river, representing about half the total number observed. The surveys were conducted using an airborne short-pulse radar system, from which water-bearing mounds could be estimated. The distribution of icing mounds was measured on a 50- to 70 km reach of each river, extending from the coast to the Sadlerochit Mountains. The ice thickness of water-bearing mounds was generally greater than 1.5 m, while icing mounds with an ice thickness of less than 1.3 m were generally dry. All mounds exceeding a height of 1.25 m over the surrounding ice surface were found to contain water.

MP 3021
INTERACTIVE MODELLING OF COLD REGIONS WATERSHEDS WITH SSARR.
Cassell, E.A., et al, *Environment Canada. National Hydrology Research Institute. NHRI symposium,* 1991, No.6, Northern hydrology: selected perspectives. Edited by T.D. Prowse and C.S.L. Ommanney, p.363-377, 18 refs.
Pangburn, T.
46-2352
WATERSHEDS, SNOWMELT, STREAM FLOW, RUNOFF FORECASTING, MODELS, HYDROLOGY, DATA PROCESSING.
Until recently, capabilities of hydrological models to account for the effect of cold regions processes on run-off forecasting have been limited by the difficulty of data acquisition and the absence of modelling environments that have convenient process-level based interactive features. The work reviewed here describes results from research on modifications that have enhanced the Streamflow Synthesis and Reservoir Regulation (SSARR) model's ability to account for cold regions effects. These investigations have led to the development of a systems dynamic model version of SSARR. This new model, SSARR- DS, provides an extremely user-friendly environment that offers convenient data input and constructive interactive features.

MP 3022
SUMMARY REPORT ON LOW TEMPERATURE AND THERMAL FATIGUE CRACKING.
Vinson, T.S., et al, *National Research Council. Strategic Highway Research Program, Washington, D.C. Report,* June 1989, SHRP-A/IR-90-001, 83p., 68 refs.
Janoo, V.C., Haas, R.C.G.
46-2606
BITUMINOUS CONCRETES, CONCRETE PAVEMENTS, CONCRETE FREEZING, CONCRETE STRENGTH, LOW TEMPERATURE TESTS, COLD STRESS, THERMAL STRESSES, CRACKING (FRACTURING), FATIGUE (MATERIALS).
Cracking of asphalt concrete pavements owing to cold temperatures or temperature cycling can occur in many regions of the United States. Cracking that results from cold temperatures generally is referred to as low temperature cracking; cracking that results from thermal cycling generally is referred to as thermal fatigue cracking. Thermal cracks permit the ingress of water, which may result in a depression at the crack because of the pumping of support materials. During the winter months, deicing solutions can enter the cracks and cause localized thawing of the base and a depression at the crack. Water entering the crack also may freeze, resulting in the formation of an ice lens, which can produce upward lipping at the crack edge. All of these effects result in poor ride quality and reduction of pavement life. Four test systems/methods warrant further consideration in a laboratory test program, as follows: Direct Tension-Constant Rate of Extension test; Thermal Stress Restrained Specimen test; C*-Line Integral test and Coefficient of Thermal Expansion and Contraction test. A test program is identified which should be conducted to provide a preliminary evaluation of the availability of selected test systems/methods (1) for standardization, and (2) to provide input parameters to mechanistic models for low temperature and thermal fatigue cracking.

MP 3023
WAVE-INDUCED ICEBERG MOTION.
Lever, J.H., et al, *Cold regions science and technology,* Nov. 1991, 20(1), p.11-23, 16 refs.
Klein, K., Mitchell, D., Diemand, D.
46-2619
ICEBERGS, HYDRODYNAMICS, WATER WAVES, ICE WATER INTERFACE, DRIFT, VELOCITY MEASUREMENT, STABILITY, DATA PROCESSING, DESIGN CRITERIA.
This paper describes the results of a three-year field study to measure the wave-induced motion of icebergs in order to examine how closely iceberg velocities, derived using wave-tank tests, reflect those of irregularly shaped full-scale icebergs. Self-contained motion-monitoring packages were deployed on icebergs in the Labrador Sea and on the Grand Banks, from which 19 data sets of wave-induced iceberg motion were obtained. These are the only available data describing the wave-induced motion of full-scale icebergs in six degrees-of-freedom. For comparison with laboratory results, computed normalized significant surge and heave iceberg velocities were computed and plotted against normalized peak wavelength. This demonstrated that velocities based on wave-tank study of four regularly shaped model icebergs do reflect the range of variation in iceberg motion attributable to random shape. The authors conclude that iceberg significant velocities are random quantities for a given size iceberg in a given sea state, and that a gamma probability density, fitted to wave-tank results, is suitable for describing their variations.

MP 3024
THERMAL CONDUCTIVITY MEASUREMENTS OF DEPTH HOAR.
Sturm, M., et al, *Journal of geophysical research,* Feb. 10, 1992, 97(B2), p.2129-2139, 52 refs.
Johnson, J.B.
46-2627
DEPTH HOAR, SNOW THERMAL PROPERTIES, THERMAL CONDUCTIVITY, METAMORPHISM (SNOW), VAPOR DIFFUSION, SNOW COVER STRUCTURE, TEMPERATURE MEASUREMENT, PROBES, TEMPERATURE EFFECTS, SNOW PHYSICS.
The effective thermal conductivity of snow (k(eff)), which includes latent heat transfer due to vapor diffusion, was measured during three winters in Fairbanks, AK. In 1986-1987, k(eff) of several layers of snow was monitored in detail as the snow metamorphosed into depth hoar. Measurements were made using a needle probe with an estimated accuracy of +/-8%; k(eff) was found to decrease and then increase as the snow passed from new snow through several distinct stages of depth hoar. For depth hoar, k(eff) ranged from 0.026 to 0.105, with an average value of 0.063 W/m/K. This is one half to one fourth the value suggested by most studies for snow of similar density. For depth hoar of a given type, k(eff) can be represented as a linear function of temperature between 0 and -20 C but requires a nonlinear function for the range from 0 to -196 C. At -196 C the thermal conductivity of depth hoar approached that of still air, suggesting that conduction through the ice skeleton of the snow was limited and that the increase in k(eff) at temperature near 0 C is the result of the strong temperature dependence of water vapor density. This conclusion is consistent with the nature of the ice bonds in depth hoar, which are thin and relatively few in number.

MP 3025
METEOROLOGICAL TRANSPORT OF CONTINENTAL SOOT TO ANTARCTICA.
Murphey, B.B., et al, *Geophysical research letters,* Jan. 3, 1992, 19(1), p.33-36, 23 refs.
Hogan, A.W.
46-2629
AEROSOLS, ATMOSPHERIC CIRCULATION, ATMOSPHERIC COMPOSITION, AIR POLLUTION, ANTARCTICA—ROSS ISLAND.
An impactor/concentrator/microdensitometer (ICM) instrument system has been constructed and calibrated. This system is sufficiently sensitive to measure the black (carbon soot) component of antarctic aerosol with a sampling time of four hours. The impactor concentrator was exposed to antarctic air at Ross I. in Sep. 1987. Microdensitometer analysis of the collected specimens indicates that the maximum black aerosol concentration was observed concurrently with the arrival of the warmest air accompanying a cyclonic storm. This is similar to the concurrence of continental radon and lead isotopes with warm advection, measured on the antarctic coast in 1986. It is possible that continental soot can be transported to the antarctic coast several times each year by this mechanism. (Auth.)

MP 3026
INTERPRETING UNCONFINED UNFROZEN WATER CONTENT.
Black, P.B., International Symposium on Ground Freezing, 6th, Beijing, Sep. 10-12, 1991. Proceedings. Ground freezing 91. Vol.1. Edited by X. Yu and C.S. Wang, Rotterdam, A.A. Balkema, 1991, p.3-6, 6 refs.
46-2733
SOIL FREEZING, FROZEN GROUND THERMODYNAMICS, UNFROZEN WATER CONTENT, SOIL WATER MIGRATION, SOIL PRESSURE.
Unfrozen water content measurements are usually obtained from unconfined specimens exposed to the atmosphere. These data are usually presented as a simple function of temperature, which presents technical difficulties in interpreting the data. These problems are relaxed if the unfrozen water content is expressed as a function of the pressure difference between the water and ice phases as given by expressions for surface tension and phase equilibrium. This interpretation is analogous to that used to describe the characteristics of ice-free soil water, so that expressions commonly used for those systems are applicable in modeling unfrozen water content.

MP 3027
TRANSPORT OF WATER THROUGH FROZEN SOILS.
Nakano, Y., International Symposium on Ground Freezing, 6th, Beijing, Sep. 10-12, 1991. Proceedings. Ground freezing 91. Vol.1. Edited by X. Yu and C.S. Wang, Rotterdam, A.A. Balkema, 1991, p.65-70, 31 refs.
46-2742
SOIL WATER MIGRATION, SOIL FREEZING, FROZEN GROUND THERMODYNAMICS, UNFROZEN WATER CONTENT, TEMPERATURE GRADIENTS, WATER TRANSPORT, WATER PRESSURE, MATHEMATICAL MODELS.
A popular hypothesis among researchers on the mechanism of water transport through frozen soils is that the flow of water under non-isothermal conditions is induced by a gradient of unfrozen water pressure that develops in response to a temperature gradient. Recent results of experimental and mathematical studies have revealed two major and independent driving forces of water: the gradients of temperature and water content in unsaturated frozen soils, and the gradients of temperature and unfrozen water pressure in saturated frozen soils. These recent results cast serious doubt upon the validity of the popular hypothesis.

MP 3028
STRENGTH OF FROZEN SOIL UNDER A COMBINED STRESS STATE.
Fish, A.M., International Symposium on Ground Freezing, 6th, Beijing, Sep. 10-12, 1991. Proceedings. Ground freezing 91. Vol.1. Edited by X. Yu and C.S. Wang, Rotterdam, A.A. Balkema, 1991, p.135-145, 31 refs.
46-2753
FROZEN GROUND STRENGTH, SOIL CREEP, FROZEN GROUND COMPRESSION, SHEAR STRESS, STRAIN TESTS, ANALYSIS (MATHEMATICS), FROZEN GROUND MECHANICS.
New parabolic yield and creep strength criteria have been developed for frozen soil (ice) under a combined stress state. The criteria take into account that the local melting of ice causes the shear strength of frozen soil to reach a maximum at a certain level of the mean normal stress, considered in the paper to be a frozen soil mechanical parameter. At low stress levels the criteria transform into the von Mises-Drucker-Prager or Mohr-Coulomb yield criteria and into the von Mises or Tresca criteria for frictionless materials. It is shown that the failure surface in the principal stress space forms a paraboloid, the shape of which depends upon the ratio of the cohesion and the friction angle on the octahedral plane and their change with time. The criteria have been verified using test data for long- term strength under six different loading regimes (uniaxial compression and tension, pure shear and triaxial compression at various mean stresses) of Kellovian silt at -10 C. It was found that the shape of the normalized curve of the long-term strength and its parameters can be considered to be independent of the loading regime, and thus all the above test data can be superimposed on this curve.

MP 3029
STRESS MEASUREMENTS IN DRIFTING PACK ICE.
Tucker, W.B., et al, *Cold regions science and technology,* Feb. 1992, 20(2), p.119-139, 28 refs.
Perovich, D.K.
46-2803
SEA ICE, PACK ICE, THERMAL STRESSES, STRESS CONCENTRATION, ICE PRESSURE, ICE COVER STRENGTH, ICE DEFORMATION, MEASUREMENT, TEMPERATURE EFFECTS.
Accurate measurements of *in-situ* pack ice forces are necessary to improve ice forecasting models and to estimate loads on offshore structures. Two months of *in-situ* ice stress measurements were obtained in the pack ice of the eastern Arctic during the fall of 1988. Sensors were placed to examine both the horizontal and vertical distributions of ice stresses in multiyear ice. Stresses in the multiyear ice 200 m from the edge of the floe reached 150 kPa during extreme deformation events. Within a few meters of the edge and in adjacent first-year ice, they exceeded 350 kPa on several occasions (400 kPa in one instance) during local ice failure events. Thermally induced stresses at shallow depths in the multiyear ice were caused by rapid temperature changes, and could be nearly as large as stresses observed during deformation. The vertical distribution of stresses varied with the type of deformation event, but the largest values were always observed in the upper half of the ice sheet. Stresses due to deformation were rapidly attenuated away from the edge of the floe. Near the edge, however, recorded stresses agreed well with those observed in the adjacent first- year ice. These two locations also experienced twice daily oscillations of about 50 kPa which are apparently tidal or inertially induced.

MP 3030
LONGITUDINAL FLOATING STRUCTURES—NEW CONCEPTS IN RIVER ICE CONTROL.
Calkins, D.J., *Canadian journal of civil engineering,* Dec. 1991, 18(6), p.933-939, With French summary. 14 refs.
46-2851
RIVER ICE, ICE JAMS, ICE PREVENTION, ICE CONTROL, FLOATING STRUCTURES, HYDRAULIC STRUCTURES, ICE COVER THICKNESS, FLOOD CONTROL, DESIGN.
Ice control structures placed in the streamwise direction of a river were analyzed to determine the effectiveness in reducing ice jam thickness. The theory describing the thickness for "wide" river ice jams was modified to analyze these longitudinal types, providing the computational verification that ice jam thicknesses could be reduced where the mode of ice cover thickening is internal collapse. These longitudinal structures appear to provide a new tool for modifying the river ice regime at freeze-up and possibly at breakup. By decreasing the ice jam thickness, which leads to lower stages, the structures have the potential for decreasing ice jam flood levels. The structures' ability to function is independent of the flow velocity, and these structures should perform in rivers with velocities greater than the usual limitation of roughly 1 m/s associated with conventional cross-channel ice booms. Other possible applications include controlling ice movement at outlets from lakes, enhancing river ice cover progression, or even restraining the ice cover at breakup. A U.S. patent application has been filed jointly by the author and U.S. Army Corps of Engineers.

MP 3031
FREEZE-THAW SLUDGE CONDITIONING AND DOUBLE LAYER COMPRESSION.
Vesilind, P.A., et al, *Canadian journal of civil engineering,* Dec. 1991, 18(6), p.1078-1083, With French summary. 11 refs.
Wallinmaa, S., Martel, C.J.
46-2852
SLUDGES, WASTE TREATMENT, FREEZE THAW CYCLES, ION DIFFUSION, FREEZING POINTS, HYGROSCOPIC WATER, SALINITY, COALESCENCE, FREEZE DRYING.
Freeze-thaw conditioning of water and wastewater sludges is known to be an effective and economical means of promoting dewatering when natural freezing is employed. When sludge freezes, both the suspended and dissolved solids are rejected by the growing ice front. Particles trapped in ice have a very thin layer of surrounding water which does not freeze at normal temperatures. Dissolved solids are thought to accumulate in this layer, causing an increase in the ionic strength of the water. This may cause compression of the double layer, leading to neutralization of repulsive forces, thus promoting aggregation. In order to test this hypothesis, ionic strength was increased by adding sodium chloride (NaCl) to water and wastewater sludges and measuring dewaterability (filtration) with a capillary suction time (CST) apparatus. Four different kinds of sludge were used: alum sludge (water treatment), waste- activated sludge, simultaneous precipitation, and anaerobically digested mixed sludge. Salinities of 0-20,000 mg/L as NaCl were tested with every sludge. No enhancement in dewaterability with freeze-thawed sludges of raised ionic strength compared to zero salinity was recorded, therefore the hypothesis of double layer compression being a major factor in freeze-thaw conditioning is apparently invalid.

MP 3032
ANTARCTIC FIELDS.
Mellor, M., Symposium on Antarctic Logistics and Operations, Fourth, Sao Paulo, Brazil, 1990. Proceedings, edited by H. Kohnen, A.J. Teixeira, and A.N. Fowler, Brasília, Brazil, Gráfica e Editora Ideal, Ltda, [1991], p.162-173, 7 refs.
46-3017
RUNWAYS, SNOW STRENGTH, BEARING STRENGTH, SURFACE ROUGHNESS.
Following a summary of recent U.S. air activities in Antarctica, aircraft runways are considered. Various airfield options from open-field landings to conventional paved runways are dealt with, the relevant factors being given in tables that cover (a) construction and maintenance and b) operations. Bearing capacity, rutting resistance, surface roughness and runway dimensions are discussed. It is concluded that a system of hard- surface runways for conventional aircraft is technically feasible. (Auth.)

MP 3033
U.S. ARMY CORPS OF ENGINEERS REAPS MANY GIS REWARDS.
Bruzewicz, A.J., *GIS world,* Mar. 1992, p.44-50.
46-3058
RESEARCH PROJECTS, DATA PROCESSING, REMOTE SENSING, MAPPING, ENVIRONMENTAL IMPACT, COMPUTER PROGRAMS.

MP 3034
SYSTEMATIC CONSIDERATION OF THE ENVIRONMENT IN THE DEVELOPMENT OF SMART WEAPONS SYSTEMS.
Link, L.E., Jr., et al, *Military engineer,* Aug. 1991, p.14-15.
West, H.W.
46-3059
INFRARED PHOTOGRAPHY, DETECTION, MILITARY RESEARCH.

MP 3035
OPERATION OF MATERIEL AT EXTREMELY LOW TEMPERATURES.
Diemand, D., *Military engineer,* Aug. 1991, p.24-25, 4 refs.
46-3060
COLD WEATHER PERFORMANCE, MILITARY EQUIPMENT, ENGINE STARTERS, LUBRICANTS, FUELS.

MP 3036
INFRARED ROOF WARRANTY INSPECTION.
Korhonen, C.J., *Military engineer,* Aug. 1991, p.32-33, 4 refs.
46-3061
ROOFS, MOISTURE DETECTION, INFRARED PHOTOGRAPHY.

MP 3037
PROGRESS IN THE IMPROVEMENT OF HDS PERFORMANCE.
Marsh, C., et al, *Military engineer,* Aug. 1991, p.34-35.
Segan, E.G., Phetteplace, G.E.
46-3062
HEATING, HEAT TRANSMISSION, MILITARY FACILITIES, WATER PIPELINES.

MP 3038
REMOTE SENSING OF THE ALASKAN AND PERSIAN GULF OIL SPILL.
Link, L.E., Jr., et al, *Military engineer,* Aug. 1991, p.52-53.
McKim, H.
46-3063
OIL SPILLS, REMOTE SENSING, SPACEBORNE PHOTOGRAPHY, DATA PROCESSING.

MP 3039
DISCUSSION OF "THE EFFECT OF LATEX GLOVES AND NYLON CORD ON GROUND WATER SAMPLE QUALITY".
Parker, L.V., *Ground water monitoring review,* Fall 1991, 2p., 13 refs. Original article by J.L. Canova and M.G. Muthig appeared in Ground water monitoring review, Spring 1991, Vol.11, No.3, p.98.
46-3064
SOIL POLLUTION, GROUND WATER.

MP 3040
PERFORMANCE OF GROUND-COUPLED HEAT PUMPS IN MILITARY FAMILY HOUSING UNITS.
Phetteplace, G.E., et al, Solar engineering, New York, American Society of Mechanical Engineers, 1992, p.377-383, 6 refs.
Ueda, H., Carbee, D.
46-3065
HEAT RECOVERY, COOLING SYSTEMS, HEAT SINKS, HEAT SOURCES, MILITARY FACILITIES, RESIDENTIAL BUILDINGS.
As part of a program to demonstrate appropriate technologies for saving energy in military facilities, 10 ground-coupled, water-to-air heat pump systems have been installed at Ft. Polk, LA. The systems were installed in housing units that are three-bedroom, two-story residences with four residences per building. Each heat pump system is coupled to two closed-loop vertical exchangers of 61-m (200-ft) depth. Five of the systems have desuperheater domestic hot water heat recovery units. The performance of each of the 10 heat pump systems is being closely monitored. In the heating mode both units with desuperheaters and units without achieved COPs (coefficients of performance) averaging 3.5. In the cooling mode, the average COP of units equipped with desuperheaters was 3.0, while those without desuperheaters achieved an average COP of 2.5.

MP 3041
DEVELOPMENT OF FIELD SCREENING METHODS FOR TNT, 2,4-DNT AND RDX IN SOIL.
Jenkins, T.F., et al, *Talanta,* 1992, 39(4), p.419-428, 27 refs.
Walsh, M.E.
46-3066
SOIL POLLUTION, SOIL CHEMISTRY, EXPLOSIVES, CHEMICAL ANALYSIS, DETECTION.
Simple field-screening methods are presented for detecting 2,4,6-TNT, 2,4-DNT and RDX in soil. A 20-g portion of soil is extracted by manually shaking with 100 ml of acetone for three minutes. After the soil settles, the supernatant is filtered and divided into three aliquots. Two aliquots are reacted with potassium hydroxide and sodium sulfite to form the red-colored Janowsky complex when 2,4,6-TNT is present or the blue-purple complex when 2,4-DNT is present. The third aliquot of the extract is passed through a strong anion exchange resin to remove nitrate and nitrite. Then the extract is acidified and RDX is reduced with zinc to nitrous acid, which is reacted with a Griess reagent to produce a highly colored azo dye. Concentrations of TNT, 2,4-DNT and RDX are estimated from their absorbances at 540, 570 and 507 nm, respectively. Detection limits are about 1 microgram/g for 2,4,6-TNT and RDX and about 2 micrograms/g for 2,4-DNT. Concentration estimates from field analyses correlate well with laboratory analyses.

MP 3042
EXPERIMENTAL STUDY OF ELECTROMAGNETIC WAVE PROPAGATION IN DENSE RANDOM MEDIA.
Koh, G., *Waves in random media,* 1992, Vol.2, p.39-48, 12 refs.
46-3067
WAVE PROPAGATION, RADAR ECHOES, ELECTROMAGNETIC PROPERTIES, SCATTERING.
Controlled experiments have been conducted to measure the propagation of synthetically generated pulses in dense random media. The dense media were prepared by embedding spherical dielectric scatterers in a homogeneous background medium; the size and volume fraction of the scatterers were the controlled parameters. A network analyzer-based system operating in the frequency domain was used to measure the electric field reflected and transmitted by slab-shaped samples of dense media as the source signal was swept from 26.5 to 40 GHz. An inverse Fourier transform was used to convert the frequency domain response into time domain pulse waveforms. The time domain response was then used to obtain pulse propagation velocity and attenuation in the controlled samples. The experimental results are shown to be in general agreement with dense medium theories.

MP 3043
EFFECTIVE DIELECTRIC CONSTANT OF A MEDIUM WITH SPHERICAL INCLUSIONS.
Koh, G., *IEEE transactions on geoscience and remote sensing,* Jan. 1992, 30(1), p.184-186, 8 refs.
46-3068
DIELECTRIC PROPERTIES, WAVE PROPAGATION, RADAR ECHOES, MICROWAVES.
The Maxwell-Garnett theory is frequently used to predict the effective, or the average, dielectric constant of a mixture composed of spherical inclusions embedded in a host medium. The effective medium theory assumes that the volume fraction occupied by the spherical inclusions is small and that the size of the inclusions is small compared to the wavelength. Experiments using controlled samples have shown that the Maxwell-Garnett theory is applicable up to an inclusion volume fraction of 0.2. At higher volume fractions, the effective dielectric constant appears to be dependent on the inclusion sizes.

MP 3044
PERFORMANCE ASSESSMENT OF FOUR ENVIRONMENTAL ANALYTICAL CONTRACT LABORATORIES.
McGee, I.E., et al, *American environmental laboratory,* Feb. 1992, 4(1), p.11-19, 3 refs.
Grant, C.L., Jenkins, T.F., Stutz, M.H.
46-3069
CHEMICAL ANALYSIS, SOIL CHEMISTRY, SOIL POLLUTION, LABORATORIES, ENVIRONMENTAL IMPACT.

MP 3045
SPECIFICATION-BASED MODIFIED CONTROL LIMITS IN QUALITY CONTROL OF TRACE CHEMICAL ANALYSES.
Grant, C.L., et al, *Association of Official Analytical Chemists International. AOAC International journal,* 1992, 75(1), p.39-45, 11 refs.
McGee, I.E., Jenkins, T.F., Stutz, M.H.
46-3070
CHEMICAL ANALYSIS, STATISTICAL ANALYSIS, LABORATORY TECHNIQUES.
Shewhart X and R charts were used to maintain and validate data quality of percent recovery estimates for 8 analytes determined by 4 procedures used routinely in 4 commercial laboratories over a 2-year period. However, because range (R) estimates of uncertainty did not include lot-to-lot calibration variability, approximately 24% of the lots were "out-of-control." The authors pooled standard deviations for S(O) (repeatability within lot), S(L) (calibration variability), and S(R) (reproducibility), which represents the total variability. Values of S(O) and S(L) were generally similar in size although there were some substantial differences between analytes and between laboratories for a given analyte. When control limits were based on reproducibility rather than repeatability, only about 6% of the lots were "out-of-control." However, these limits are less convenient to compute at the bench, within-lot precision estimates are still required, and there is still no information on data acceptability. Capability estimates from the grand mean +/-3 S(R) were surprisingly consistent for the 8 analytes. These values coupled with data quality objectives suggested the 82-115% range as the specifications for acceptable individual recoveries. A combination of repeatability limits plus modified limits anchored to specifications retains the simplicity of range computations while offering substantial administrative advantages. Examples are given to illustrate these points.

MP 3046
APPARENT DONOR-ACCEPTOR INTERACTION BETWEEN NITROAROMATICS AND ACETONITRILE.
Leggett, D.C., et al, *Journal of solution chemistry,* 1992, 21(1), p.105-108, 11 refs.
Miyares, P.H., Jenkins, T.F.
46-3071
HYDROGEN BONDS, SOLUTIONS, CHEMICAL PROPERTIES, EXPLOSIVES, WATER CHEMISTRY, HYDROCARBONS.
The partitioning behavior of nitro-aromatics in octanol-water and acetonitrile/NaCl-saturated water was examined. The nitro group contribution is opposite in the two systems, from which two different bonding mechanisms were inferred. In addition to cavity effects the octanol-water system is characterized by H-bonding of water to the nitro groups, while in the acetonitrile/NaCl-saturated water system electron donor-acceptor complexation predominates. A linear free-energy relationship which relates the partition coefficients in the two systems was $\log P(aw) = 0.727 \log P(ow) + 0.395 n + 0.742$, where n is the number of nitro groups per ring.

MP 3047
COUPLED VERTICAL AND HORIZONTAL GALLOPING.
Jones, K.F., *Journal of engineering mechanics,* Jan. 1992, 118(1), p.92-107, 26 refs.
46-3072
POWER LINE ICING, ICE LOADS, WIND PRESSURE, VIBRATION, ANALYSIS (MATHEMATICS).
Galloping can occur when wind blows on ice-coated conductors. In this paper, the linearized coupled vertical-horizontal galloping equations are derived and the eigenvalues defining the motion are determined analytically. The intrinsic coupling between the vertical and horizontal equations requires that there be no vertical motion if the horizontal motion is constrained. Furthermore, vertical galloping may be initiated by a horizontal displacement or velocity. The solution of the eigenvalue equation indicates that the coupled galloping criterion may be either more or less stringent than Den Hartog's criterion. The galloping trajectory is either a straight line at a small angle to the vertical, or under more extreme conditions, defines an elliptical envelope. Solutions are obtained for four cases chosen from the literature to illustrate the effect of different combinations of values of the aerodynamic parameters.

MP 3048
PASSIVE MICROWAVE REMOTE AND *IN SITU* MEASUREMENTS OF ARCTIC AND SUBARCTIC SNOW COVERS IN ALASKA.
Hall, D.K., et al, *Remote sensing of environment,* 1991, Vol.38, p.161-172, 46 refs.
Sturm, M., Chacho, E.F., Jr.
46-3073
SNOW SURVEYS, SNOW COVER DISTRIBUTION, SNOW DEPTH, SNOW STRATIGRAPHY, SNOW DENSITY, SNOW TEMPERATURE, MICROWAVES, RADIOMETRY, UNITED STATES —ALASKA.
Between 11 and 19 Mar. 1988, airborne and satellite passive microwave measurements were acquired simultaneously with ground measurements of depth, density and stratigraphy of the snow in central and northern Alaska. Five aircraft flights were flown along a north-south transect between about 147N and 152W, and extending from about 63N (south of Fairbanks, AK) to the Arctic Ocean coastline, with an Aircraft Multichannel Microwave Radiometer (AMMR) onboard operating at 92, 37, 21, and 18 GHz. Passive microwave data from the satellite-borne Special Sensor Microwave Imager (SSMI), operating at 85.5, 37, 21, 18, and 10 GHz, were obtained concurrently. A good correspondence in brightness temperature (TB) trends between the aircraft and satellite data was found. However, an expected inverse correlation between depth hoar thickness and TB was not found to be strong. A persistent TB minimum in both the aircraft and the satellite data was detected along the northern foothills of the Brooks Range. In an area located at about 69N, 149W, the TB as recorded from the aircraft microwave sensor dropped by 55 K. Satellite microwave measurements showed a TB decrease of up to 45 K at approximately the same location. Snow pit measurements did not reveal notable differences in snow characteristics or depth in this location. An examination of passive microwave satellite data from 1978 to 1987 revealed that similar low late-winter TB values were found in approximately the same locations as those observed in Mar. 1988. According to the satellite data, the zone of low TB develops as the snow deepens, and reaches the lowest values in Mar. or Apr. each year. The cause of this TB minimum is unknown, but thought to be related to snow stratigraphy. The observed difficulty in relating the ground measurements to data collected using aircraft and satellite passive microwave sensors is attributed to the fact that the snow depth and character are highly variable in central and northern Alaska. This variability is exemplified in the field measurements as well as in the passive microwave measurements.

MP 3049
DYNAMICS OF INFRARED AND MILLIMETER-WAVE ENVIRONMENTS ISSUES FOR SCENE SIMULATION.
Davis, R.E., et al, Ground Target Modeling and Validation Conference, 2nd. Proceedings, Houghton, Michigan Technological University, Aug. 1991, 15p., 18 refs.
Boyne, H.S., Nagle, J.A., Link, L.E., Jr.
46-3074
RADAR ECHOES, SNOW COVER EFFECT, ENVIRONMENT SIMULATION, INFRARED RECONNAISSANCE, SNOW THERMAL PROPERTIES, TEMPERATURE MEASUREMENT, SURFACE TEMPERATURE, BACKSCATTERING.
The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) is conducting research to understand and predict the interaction of electromagnetic radiation with cold regions environments. The CRREL efforts are a component of the U.S. Army Corps of Engineers Scene Dynamics Program which is designed to measure the environmental conditions during seeker/sensor field tests, to identify mechanisms by which the environment affects performance, and to develop a sufficient characterization of the environment to model the electromagnetic background response. The environmental effects can then be assessed quantitatively and incorporated into the sensor system design. During the winters of 1988, 1990, and 1991, CRREL conducted field tests to monitor background scene dynamics during the Joint Munitions Test and Evaluation Program Office (CHICKEN LITTLE JPO) captive flight tests at Grayling, MI. This paper presents an analysis of the effects of environmental processes on sensor performance based on the 1990 data. The impact of environmental variability on infrared and millimeter-wave systems will be stressed. A decision tree approach is used to classify expected sensor system performance as a function of near-surface meteorological conditions which affect the surface energy exchange. Issues for distributing this approach spatially to mixed background scenes will be discussed.

MP 3050
MOVING BOUNDARY STEP ICE FORMATION IN TURBULENT FLOW.
Albert, M.R., Numerical methods in thermal problems, Vol.VII, edited by R.W. Lewis, et al, Swansea, Wales, Pineridge Press, 1991, p.101-111, 14 refs.
46-3075
TURBULENT FLOW, ICE FORMATION, LIQUID SOLID INTERFACES, PHASE TRANSFORMATIONS, HEAT TRANSFER, BOUNDARY VALUE PROBLEMS, MATHEMATICAL MODELS.
For solidification processes involving fluid flow in the melt, the nature of the flow field has a profound influence on the configuration of the solid-liquid interface, especially when the flow is turbulent. In order to investigate solidification problems in turbulent flow, a numerical moving boundary method is presented for arbitrary geometries in two dimensions. It is the first moving mesh method to include the solution of the turbulent flow field as part of the calculations. The importance of including detailed calculations in the flow field is illustrated in an application involving ice formation in turbulent flow between parallel plates. The application illustrated here represents the first theoretical prediction of irregular ice profiles resulting from freezing of flow in a uniform duct with uniform boundary conditions.

MP 3051
ANTICIPATING ENVIRONMENTALLY RELATED CHANGES IN THE DETECTION CAPABILITY OF EXTERIOR INTRUSION DETECTION SYSTEMS.
Peck, L., Northbrook, IL, Institute of Nuclear Material Management, 1991, p.546-550, 4 refs. Presented at the 32nd annual meeting, New Orleans, July 2-31, 1991.
46-3076
DETECTION, WARNING SYSTEMS, SITE ACCESSIBILITY, COLD WEATHER TESTS.
Changes in detection capability due to winter and transitional environments have been determined for several exterior intrusion detection systems (IDS) by means of controlled intrusions and long-term monitoring of IDS performance. These changes have been evaluated in terms of environmental effects on the phenomenology by which each IDS detects an intruder. This paper summarizes the dependence of detection capability on operating environment. It identifies the site conditions (weather, snow cover, frozen/thawed state of the ground) that should be monitored in order to anticipate when and what changes in detection capability are occurring. Guided by an awareness of IDS performance as a function of the environment, security personnel may avoid vulnerabilities in detection capability by adjusting IDS sensitivity to maintain the required probability of detection without incurring unacceptable nuisance alarm rates.

MP 3052
RELAXATION OF THE SECOND MOMENTS IN RAPID SHEAR FLOWS OF SMOOTH DISKS.
Louge, M.Y., et al, U.S./Japan Conference on the Micro-Mechanics of Granular Materials, 4th, Potsdam, NY, Aug. 4-7, 1991. Proceedings, 1991, 9p., 2 refs.
Jenkins, J.T., Hopkins, M.A.
46-3077
SHEAR FLOW, AVALANCHE MODELING, MATHEMATICAL MODELS.
This paper compares the results of numerical simulations for two-dimensional, rapid, homogeneous shear flows of identical smooth inelastic disks with the predictions of Jenkins and Richman for the relaxation of the second moments of the velocity distribution function following a homogeneous but anisotropic disturbance of their steady values. For nearly elastic disks, the time-history of the relaxation is in excellent agreement with the theory in both its dense and dilute limits. However, deviations are observed in the case of inelastic particles.

MP 3053
ON THE STRUCTURE OF 3D SHEAR FLOWS.
Hopkins, M.A., et al, U.S./Japan Conference on the Micro-Mechanics of Granular Materials, 4th, Potsdam, NY, Aug. 4-7, 1991. Proceedings, 1991, 9p., 11 refs.
Jenkins, J.T., Louge, M.Y.
46-3078
SHEAR FLOW, AVALANCHE MODELING, STATISTICAL ANALYSIS.
This paper describes an investigation of structure in moderately dilute three-dimensional shear flows. Structure is defined as a dynamic inhomogeneity or fluctuation in the spatial concentration field. Numerical experiments are performed with large numbers of identical frictionless, inelastic spheres. The spheres are contained in a fully periodic cubic control volume. A state of shear is maintained in the control volume by moving the upper periodic image in one direction and the lower image in the opposite direction. As the coefficient of restitution of the spheres is lowered, conditions in the control volume deviate from a state of simple shear, exhibiting strong wavelike fluctuations in the concentration, stress, and velocity fields. Visual inspection of the spatial concentration field reveals a strong tendency for spheres with a low coefficient of restitution to form dense clouds. The clouds are, in general, oriented such that they are aligned with the mean velocity and normal to the direction of the mean velocity gradient created by the moving periodic images of the control volume.

MP 3054
SPATIAL VARIABILITY OF CACO3 SOLUBILITY IN A CHIHUAHUAN DESERT SOIL.
Marion, G.M., et al, *Arid soil research and rehabilitation,* 1990, Vol.4, p.181-191, 24 refs.
Schlesinger, W.H., Fonteyn, P.J.
46-3079
SOIL CHEMISTRY, DESERT SOILS, GEOCHEMISTRY, SOLUBILITY, NUTRIENT CYCLE, SOIL PROFILES, UNITED STATES—NEW MEXICO.
Spatial variability in CaCO3 solubility is an important factor in parameterizing simulation models and designing experiments. The objective of this study was to quantify the spatial variability, both horizontal and vertical, in CaCO3 solubility in a Chihuahuan Desert soil. CaCO3 solubilities were estimated in 1:5 soil:water suspensions. Soil horizon extracts were generally supersaturated with respect to calcite. The mean (+/-1 SE) pIAP(CaCO3) for the A, B(k1), and B(k2) horizons were 8.03 (0.055), 8.19 (0.019), and 8.26 (0.015), respectively. The differences in pIAP between the A and B horizons (vertical variability) were statistically significant; these differences could be due to organic matter inhibition of calcite precipitation. Supersaturation with respect to calcite and vertical variability in CaCO3 solubility needs to be explicitly considered in simulation models. The standard errors in pIAP (horizontal variability) were greatest for the A horizons and decreased with increasing soil depth. Given the inherent variability in CaCO3 solubility, a large sample size is necessary to detect small differences in CaCO3 solubility for this Chihuahuan Desert soil.

MP 3055
STABLE ISOTOPE GEOCHEMISTRY OF CACO3 ON THE TANANA RIVER FLOODPLAIN OF INTERIOR ALASKA, U.S.A.: COMPOSITION AND MECHANISMS OF FORMATION.
Marion, G.M., et al, *Chemical geology. Isotope geoscience section,* 1991, Vol.86, p.97-110, 43 refs.
Introne, D.S., Van Cleve, K.
46-3080
SOIL CHEMISTRY, GEOCHEMISTRY, REVEGETATION, ISOTOPE ANALYSIS, NUTRIENT CYCLE, FOREST SOILS, FLOODPLAINS, PLANT ECOLOGY, EVAPOTRANSPIRATION, UNITED STATES—ALASKA—TANANA RIVER.
On the river floodplains of interior Alaska, forests exist on calcareous, alluvial soils. The objectives of this study were to determine the stable C-13 and O-18 isotopic composition of CaCO3 along a plant primary successional sequence (250 yr.) and to examine possible mechanisms controlling the formation of CaCO3 in these floodplain soils. Soil samples were analyzed from duplicate plots of three successional stages: open shrub (Stage III, 4 yr. old), young balsam poplar-alder (Stage V, 30 yr. old), and mature white spruce (Stage VIII, 170-250 yr. old). The early stages of plant succession showed little variation in the mean soil delta C-13 PDB (-4.3 to -4.0 per mill), while the Stage VIII sites showed the greatest carbon depletion (delta C-13 PDB=-7.9 to -6.2 per mill). The mean soil delta O-18 PDB values ranged from -16.3 to -14.6 per mill. These low delta O-18 values reflect, in part, the very depleted meteoric precipitation (delta O-18 PDB=-50.3 per mill) for this cold continental site. A few surface "salt crust" samples showed significant enrichment in both C and O isotopes. Six calcite-bearing rock samples from the Alaska Range, the source of the alluvial parent material, fell into two classes with means for delta C-13 PDB of -0.2 and -5.2 per mill and means for delta O-18 PDB of -14.6 and -18.7 per mill, respectively. The early Stage III profiles showed little variation in isotopic composition with soil depth, suggesting that the CaCO3 was primarily inherited with the alluvial material and was not formed in situ. Surface evaporation of water played a minor role and transpirational loss of water played a major role in altering the isotopic composition of soil CaCO3 along the successional sequence. There was no evidence to support freezing as a mechanism controlling soil CaCO3 precipitation. Over the 170-250 yr-old plant successional sequence, the biotic factor significantly altered the isotopic composition of soil CaCO3.

MP 3056
PILOT-SCALE STUDY OF ALUM SLUDGE DEWATERING IN A FREEZING BED.
Martel, C.J., et al, *American Water Works Association. Journal,* Dec. 1991, 83(12), p.51-55, 13 refs.
Diener, C.J.
46-3081
SLUDGES, ARTIFICIAL FREEZING, SEWAGE TREATMENT, WATER TREATMENT, FREEZE THAW CYCLES.
The purpose of this study was to demonstrate the capability of a sludge-freezing bed for dewatering alum sludge. Alum sludge containing average total solids of 0.5% was applied to the pilot-scale bed and frozen in layers 2-10 cm thick over the winter of 1989-90. By the end of the winter, 99 cm of sludge had been frozen. After thawing and draining of meltwater, the depth of sludge remaining in the bed was reduced to 3-5 cm, a 96% reduction in volume. The remaining solids had a granular consistency similar to medium-sized sand. The meltwater drained through the granular solids as easily as through the underlying sand. Column tests show that these granular solids could accumulate in the bed for several years before removal would be necessary.

MP 3057
LONG-TERM CHANGES IN SOIL AND PLANT METAL CONCENTRATIONS IN AN ACIDIC DREDGE DISPOSAL SITE RECEIVING SEWAGE SLUDGE.
Palazzo, A.J., et al, *Water, air, and soil pollution,* 1991, Vol.57/58, p.839-848, 28 refs.
Reynolds, C.M.
46-3082
SEWAGE DISPOSAL, SLUDGES, SOIL CHEMISTRY, PLANT PHYSIOLOGY, PLANT TISSUES, REVEGETATION, WASTE DISPOSAL, LAND RECLAMATION.
A long-term experiment was conducted to determine the distribution of sludge-borne metals applied to a revegetated acidic dredge spoil disposal site. The initial soil was infertile and highly acidic (pH 2.4). Sewage sludge and lime were applied in 1974 at the rates of 100 and 23 metric tons/ha, respectively, and tilled into the soil to a depth of 20 cm. In 1974 an adjacent site was also revegetated with topsoil and lime but without sludge. Soil and plants were sampled 2, 4 and 16 yr following seeding. After 16 yr the total and DTPA-extractable Cu, Zn, Cr, Pb, Ni and Cd decreased in soils to nearly the levels of the control soils. Concentrations of metals in plants also decreased. Decreases in tissue concentrations ranged from 40 to 70% for Cu, Cr, Pb, Ni and Cd and up to 90% for Zn. The results showed that a single 100 metric tons/ha application of sewage sludge containing high concentrations of metals was a cost-effective method for improving plant growing conditions on highly acidic soils.

MP 3058
CAN LONG-PATH FTIR SPECTROSCOPY YIELD GAS FLUX MEASUREMENTS THROUGH A VARIANCE TECHNIQUE.
Andreas, E.L., et al, *Atmospheric environment,* 1992, 26A(2), p.225-233, 44 refs.
Gosz, J.R., Dahm, C.N.
46-3083
ATMOSPHERIC COMPOSITION, INFRARED SPECTROSCOPY, TURBULENT EXCHANGE, GASES, BOUNDARY LAYER, VAPOR TRANSFER, STATISTICAL ANALYSIS.
Long-path Fourier transform infrared (FTIR) spectroscopy is capable of measuring concentrations of many environmentally important trace gases in the atmospheric surface layer over horizontal averaging paths of up to 1 km. If the FTIR could also measure the variance in gas concentrations, one could conceivably use it to estimate the path-averaged vertical flux of any gas that the FTIR can detect. The problem in measuring variances, however, is that the large

sampling volume—which allows the FTIR to measure concentrations with the best resolution—degrades its response to the high-wavenumber turbulent fluctuations that contribute to the variance. In this paper, the authors use a model for the three-dimensional scalar spectrum to look at the effects of this volume averaging on the FTIR's ability to measure gas concentration variance. The modeling suggests that there is no realistic configuration or sampling rate that will let the FTIR measure gas concentration variance in the surface layer. Its sampling volume must simply be so large that all turbulent fluctuations with wavenumbers from the dissipation region down to the vicinity of the spectral peak are irrevocably degraded. Analysis identifies experiments that can test these predictions. Despite the FTIR's predicted inability to measure gas fluxes through the variance technique, it is shown that it can still yield these fluxes through other micrometeorological techniques.

MP 3059
FREEZING OUT SLUDGE.
Martel, C.J., *Civil engineering,* Nov. 1991, 61(11), p.64-65.
46-3084
SLUDGES, WATER TREATMENT, SEWAGE TREATMENT, ARTIFICIAL FREEZING.

MP 3060
COMBATTING ICE DAMS AND SLIDING SNOW ON ROOFS.
Tobiasson, W., *American Public Works Association. APWA reporter,* Sep. 1991, 58(9), p.18-19.
46-3090
ROOFS, ICE CONTROL.

MP 3061
SEA-ICE STUDIES ON THE WINTER WEDDELL GYRE STUDY, 1989.
Meese, D.A., et al, *Antarctic journal of the United States,* 1990, 25(5), p.116-117, 4 refs.
Govoni, J.W., Lytle, V.I., Claffey, K., Ackley, S.F.
46-3189
ICE CORES, ICE SURVEYS, ICE PHYSICS, REMOTE SENSING, SNOW, SEA ICE, ICE COMPOSITION.
The U.S. Army Cold Regions Research and Engineering Laboratory participated in the Winter Weddell Gyre Study, 1989 on both the *Polarstern* and the *Akademik Fedorov.* On the *Polarstern,* remote sensing work was performed with two radars, and the authors assisted in the ice properties studies. On the *Akademik Fedorov,* they conducted studies on the physical, optical, chemical, and biological properties of the sea ice and carried out a detailed ice thickness study. For 12 days during the study, the *Akademik Fedorov* was moored to an ice floe to conduct extensive oceanographic and ice studies. Ice cores were collected to sample all of the various ice types available. Optical measurements were taken at 5 different locations in the area according to various ice type and thickness. In addition, five thickness profiles including a grid were taken through all anomalous locations, and one was taken in the usual manner to determine variations that may exist.

MP 3062
SNOW AND SEA-ICE THICKNESSES: WINTER WEDDELL GYRE STUDY, 1989.
Meese, D.A., et al, *Antarctic journal of the United States,* 1990, 25(5), p.118, 6 refs.
Govoni, J.W., Ackley, S.F.
46-3190
SEA ICE, ICE COVER THICKNESS, SNOW DEPTH, SNOW COVER EFFECT, ANTARCTICA—WEDDELL SEA.
During the Winter Weddell Gyre Study, 1989, 2,650 thickness holes were drilled at 29 different sites in the pack ice on the Weddell Sea from the Soviet icebreaker *Akademik Fedorov.* The primary objective of the study was to determine ice thickness, snow thickness, and freeboard variations within and among floes, and to examine the variations of these properties with geographic location in the Weddell Sea. Snow thicknesses ranged from 0 to 80 cm with a mean of 17.9 cm; ice thicknesses ranged from 0 to 279 cm with a mean of 64.9 cm; and freeboards ranged from -32 to 55 cm with a mean of 1.5 cm. Negative freeboards indicate that the top ice surface is below sea level; flooding of the ice was often observed at these locations. The values were visually examined in relation to latitude and longitude to determine if there was any consistent variation over the cruise track. A consistent trend was not evident.

MP 3063
OPTICAL MEASUREMENTS ON SEA ICE FROM THE WEDDELL SEA, ANTARCTICA.
Govoni, J.W., et al, *Antarctic journal of the United States,* 1990, 25(5), p.121-122, 6 refs.
Meese, D.A., Perovich, D.K.
46-3192
ICE PHYSICS, ICE STRUCTURE, SEA ICE, OPTICAL PROPERTIES, ICE COMPOSITION, SNOW COVER, ANTARCTICA—WEDDELL SEA.
During the 1989 Winter Weddell Gyre Study, combined optical and physical properties measurements were made of first-year sea ice in the Weddell Sea. Optical measurements consisted of incident, reflected, and transmitted spectral irradiances. An essential adjunct to the optical measurements was a complete characterization of the physical state and structure of the ice. This was accomplished by taking two ice cores from each site. When snow cover was present, its depth and stratigraphy were also recorded. Snow cover properties were characterized in terms of depth, density, grain size, and temperature for each layer. Photographs were also taken at each site and a general description of the ice, snow, and sky conditions was recorded.

MP 3064
RADAR BACKSCATTER MEASUREMENTS DURING THE WINTER WEDDELL GYRE STUDY.
Lytle, V.I., et al, *Antarctic journal of the United States,* 1990, 25(5), p.123-125, 5 refs.
Jezek, K.C., Gogineni, S.P., Moore, R.K., Ackley, S.F.
46-3193
SNOW, SEA ICE, ICE SURFACE, RADAR, ICE COVER THICKNESS, ICE COMPOSITION, ICE DENSITY, ANTARCTICA—WEDDELL SEA.
Data primarily taken over first and second year ice during the Weddell Sea cruise of F.S. *Polarstern* in Sep. and Oct. 1989 are discussed. Radar measurements were conducted in conjunction with detailed snow and ice measurements, including snow and ice thickness, surface roughness, salinities, and densities. One of the salient features found in the Weddell Sea second year ice, in contrast to arctic second year ice, was a deep snow cover which depressed the ice surface below sea level, causing brine to infiltrate into the snow and creating a highly saline layer at the snow/ice interface. An associated slush layer was observed where the snow had been flooded but had not refrozen. Because of either the high salinity layer or the presence of slush at the snow/ice interface observed in the Weddell Sea, the radar penetration depth is less, leading to a reduction in volume scattering relative to arctic sea ice.

MP 3065
GLACIER TERMINUS FLUCTUATIONS IN THE WRANGELL AND CHUGACH MOUNTAINS RESULTING FROM NON-CLIMATIC CONTROLS.
Sturm, M., et al, International Conference on the Role of the Polar Regions in Global Change, Fairbanks, June 11-15, 1990. Proceedings, Vol.2, Fairbanks, University of Alaska, Dec. 1991, p.519-523, 26 refs.
Hall, D.K., Benson, C.S., Field, W.O.
46-3215
GLACIER OSCILLATION, GLACIER FLOW, VOLCANOES, MOUNTAIN GLACIERS, GLACIER SURVEYS, GLACIER BEDS, UNITED STATES—ALASKA.
Non-climatically controlled fluctuations of glacier termini were studied in two regions in Alaska. In the Wrangell Mountains, eight glaciers on Mt. Wrangell, an active volcano, have been monitored over the past 30 years using terrestrial surveys, aerial photogrammetry and digitally registered satellite images. Results, which are consistent between different methods of measurement, indicate that the termini of most glaciers were stationary or had retreated slightly. However, the termini of the 30-km-long Ahtna Glacier and the smaller Center and South MacKeith glaciers began to advance in the early 1960s and have advanced steadily at rates between 5 and 18 m/yr since then. These three glaciers flow from the summit caldera of Mt. Wrangell near the active North Crater, where increased volcanic heating since 1964 has melted over 70 million cu m of ice. The authors suggest that volcanic meltwater has changed the basal conditions for the glaciers, resulting in their advance. In College Fjord, Prince William Sound, the terminus fluctuations of two tidewater glaciers have been monitored since 1931 by terrestrial surveying, photogrammetry, and most recently, from satellite imagery. Harvard Glacier, a 40-km-long tidewater glacier, has been advancing steadily at nearly 20 m/yr since 1931, while the adjacent Yale Glacier has retreated at approximately 50 m/yr during the same period, though for short periods both rates have been much higher. The striking contrast between the terminus behavior of Yale and Harvard Glaciers, which parallel each other in the same fjord, and are derived from the same snow field, supports the hypothesis that their terminus behavior is the result of dynamic controls rather than changes in climate.

MP 3066
POLAR CLIMATE ITERATION?.
Hogan, A.W., et al, International Conference on the Role of the Polar Regions in Global Change, Fairbanks, June 11-15, 1990. Proceedings, Vol.2, Fairbanks, University of Alaska, Dec. 1991, p.681-686, 38 refs.
46-3237
POLAR ATMOSPHERES, ATMOSPHERIC COMPOSITION, AIR MASSES, AIR ICE WATER INTERACTION, AEROSOLS, ATMOSPHERIC CIRCULATION, ANTARCTICA—AMUNDSEN-SCOTT STATION.
A continuous series of surface observations began at South Pole in 1974 and have continued to the present. Although a large seasonal variation in aerosol concentration is present, little year-to-year variation in mean seasonal aerosol concentration occurred prior to 1982. During the mid-1980s, a consistent diminution of mean annual aerosol concentration was observed, and a concurrent reduction in sodium concentration in snow and firn was reported. The decrease in aerosol concentration was greatest in late winter and spring, concurrent with decreases in mean air temperature and mean wind speed. This paper describes concurrent aerosol and meteorological data collected at South Pole from 1974 through 1987 and presents several analyses attempting to verify if these changes do reflect a persistent variation in the properties of the antarctic continental air mass. Additional analyses, using upper air and automatic weather station data, attempt to identify circulation changes related to these changes in aerosol concentration. (Auth. mod.)

MP 3067
ALASKA WATER ISSUES. Fairbanks, American Water Resources Association, Alaska Section. University of Alaska, Water Research Center, 1992, 209p., WRC-114, Refs. passim. Proceedings of the AWRA Alaska Section annual meeting, Apr. 9-10, 1992. For selected papers see 46-3263 through 46-3276.
Chacho, E.F., Jr., ed.
46-3262
WATER POLLUTION, WATER CHEMISTRY, WATER RESERVES, WETLANDS, SOIL POLLUTION, WATER TREATMENT, PERMAFROST HYDROLOGY, UNITED STATES—ALASKA.

MP 3068
TRAVEL DISTANCES OF COARSE SEDIMENT PARTICLES IN RIVERS.
Burrows, R.L., et al, Alaska water issues, Fairbanks, American Water Resources Association, Alaska Section. University of Alaska, Water Research Center, 1992, p.89-90, 7 refs. Presented at the AWRA Alaska Section annual meeting, Apr. 9-10, 1992.
Chacho, E.F., Jr., Emmett, W.W.
46-3269
SEDIMENT TRANSPORT, SUSPENDED SEDIMENTS, RIVER FLOW.

MP 3069
WHITE PHOSPHOROUS CONTAMINATION OF AN ALASKAN SALT MARSH: EAGLE RIVER FLATS.
Collins, C.M., et al, Alaska water issues, Fairbanks, American Water Resources Association, Alaska Section. University of Alaska, Water Research Center, 1992, p.99, Presented at the AWRA Alaska Section annual meeting, Apr. 9-10, 1992.
Racine, C.H., Walsh, M.E.
46-3271
WETLANDS, SOIL POLLUTION, ENVIRONMENTAL IMPACT, EXPLOSIVES, BOTTOM SEDIMENT, MILITARY FACILITIES, UNITED STATES—ALASKA—FORT RICHARDSON.

MP 3070
ROAD AND AIRPORT PAVEMENT RESPONSE MONITORING SYSTEMS.
Janoo, V.C., ed, New York, American Society of Civil Engineers, 1992, 429p., Refs. passim. Proceedings of a conference sponsored by the U.S. Army Cold Regions Research and Engineering Laboratory, West Lebanon, NH, Sep. 12-16, 1991. For selected papers see 46-3323 through 46-3330.
Eaton, R.A., ed.
46-3322
PAVEMENTS, SOIL TRAFFICABILITY, GROUND THAWING, FROST RESISTANCE, THAW WEAKENING, SEASONAL FREEZE THAW, STRAIN MEASURING INSTRUMENTS.

MP 3071
INSTRUMENTATION FOR VEHICLE MOBILITY TESTING IN THE FROST EFFECTS RESEARCH FACILITY.
Berliner, E., et al, Road and airport pavement response monitoring systems. Edited by V.C. Janoo and R.A. Eaton, New York, American Society of Civil Engineers, 1992, p.12-26, 4 refs.
Shoop, S.A.
46-3323
GROUND THAWING, SOIL TRAFFICABILITY, TRACTION, FROST PENETRATION, THAW DEPTH, LABORATORIES, MEASURING INSTRUMENTS, TEST EQUIPMENT.
Vehicle mobility in thawing soils is currently being studied in the Cold Regions Research and Engineering Laboratory's (CRREL) Frost Effects Research Facility (FERF). The instrumentation used to accomplish this can be divided into two classes. One set of instruments is devoted solely to determination of soil conditions and is imbedded in the test surface. This set consists of thermistors for determining depth of freeze, and tensiometers for determining moisture content. The remainder of the instruments are mounted on the vehicle and are used to measure speed, force, and temperature. The CRREL instrumented vehicle (CIV) is equipped with a fifth wheel and ultrasonic speed sensor for measuring vehicle speed, and proximity gauges and counters for measuring individual wheel speeds. The forces at the interface between the tire and the ground are measured by triaxial load cells. These load cells sense longitudinal (direction of travel), transverse (perpendicular to direction of travel), and vertical forces on the tire. Vehicle temperature is measured using thermocouples.

MP 3072
INSTRUMENTATION FOR CHARACTERIZING SEASONAL CHANGE IN PROPERTIES OF PAVEMENT STRUCTURES.
Haupt, R.S., et al, Road and airport pavement response monitoring systems. Edited by V.C. Janoo and R.A. Eaton, New York, American Society of Civil Engineers, 1992, p.125-137, 6 refs.
Bull, D.C.
46-3324
GROUND THAWING, THAW WEAKENING, SOIL TRAFFICABILITY, PAVEMENTS, MEASURING INSTRUMENTS, SEASONAL FREEZE THAW.

Pavement analysis techniques have been unable to effectively predict and account for variations in the in situ properties of pavement structures as their relative strengths adjust to seasonal changes in moisture and temperature. A joint research project between the Vermont Agency of Transportation (VAOT) and the U.S. Army Cold Regions Research & Engineering Laboratory (CRREL) has been initiated to evaluate in situ variations in the moduli of representative pavement layers as their structural properties are influenced by seasonal changes. Seven tests at five locations representing diversified examples of pavement sections and conditions are being instrumented to measure variations in support strength characteristics resulting from seasonal changes in weather, moisture and temperature. The objective of this paper is to present examples of prior and future instrumentation that has been investigated in an attempt to obtain the information necessary for effective evaluation of support characteristics that are needed for optimizing pavement design procedures.

MP 3073
MEASUREMENT OF SHOCK PRESSURE FROM FWD ON A CONCRETE PAVEMENT BY IMPEDANCE-MATCHED SHOCK GAUGE.
Dutta, P.K., et al, Road and airport pavement response monitoring systems. Edited by V.C. Janoo and R.A. Eaton, New York, American Society of Civil Engineers, 1992, p.213-228, 7 refs.
Kalafut, J.
46-3329
CONCRETE PAVEMENTS, STRAIN MEASURING INSTRUMENTS, SOIL STRENGTH, CONCRETE STRENGTH, IMPACT TESTS, SHOCK WAVES.

This paper summarizes the installation, acquisition, and analysis of data from impedance-matched shock gauges developed at CRREL and installed in the Frost Effects Research Facility experimental pavement. The gauges were made with shock sensitive piezopolymer sensors embedded in specially formulated materials to match the shock impedance of concrete and soils in which they were installed. Measured data were compared with the values predicted from Boussinesq's solution for concentrated load modified for uniformly distributed circular load. Results from the numerical analysis using the computer code JULEA were also compared. Measured data are in greater agreement (within 15%) with the results predicted from the numerical analysis than with the modified Boussinesq solution. The shock gauges continued to function over a period of three months without any degradation.

MP 3074
HYDRAULIC/GEOMORPHIC RELATIONSHIPS IN A BRAIDED TO MEANDERING TRANSITION.
Neill, C.R., et al, XXIV IAHR Congress, Madrid, Sep. 9-13, 1991, Madrid, International Association for Hydraulic Research, 1991, p.A/139-A/147, 9 refs.
Collins, C.M.
46-3369
RIVER FLOW, SEDIMENT TRANSPORT, CHANNELS (WATERWAYS), FLOOD CONTROL, HYDRAULICS, UNITED STATES—ALASKA—TANANA RIVER.

MP 3075
COMPUTER SIMULATIONS OF RAPID GRANULAR FLOWS INTERACTING WITH A FLAT, FRICTIONAL BOUNDARY.
Louge, M.Y., et al, New York, American Society of Civil Engineers, 1991, 6p., 2 refs. Presented at the ASCE conference, Columbus, OH, May 20-22, 1991.
Jenkins, J.T., Hopkins, M.A.
46-3109
RHEOLOGY, SHEAR FLOW, COMPUTERIZED SIMULATION, PRESSURE RIDGES, FLUID MECHANICS, BOUNDARY VALUE PROBLEMS.

MP 3076
OBSERVED ICE PASSAGE FROM LAKE HURON INTO THE ST. CLAIR RIVER.
Daly, S.F., *Journal of great lakes research,* 1992, 18(1), p.61-69, 8 refs.
46-3611
LAKE ICE, RIVER ICE, ICE PASSING, ICE CONDITIONS, ICE FORECASTING, PHOTOINTERPRETATION, STATISTICAL ANALYSIS, ICE JAMS, SURFACE STRUCTURE, UNITED STATES—ST. CLAIR RIVER.

Ice entering the St. Clair River from southern Lake Huron has caused large ice jams on the river, which have inundated large inhabited areas and delayed navigation. Study and forecasting of these ice jam events require that the ice passage from the lake into the river be described quantitatively. This paper analyzes data obtained from time-lapse photography of ice conditions at the entrance of the river at Lake Huron over six winters. For each day of record when ice was observed in Lake Huron or the river, the presence or absence of an ice arch and the daily average surface concentration of ice entering the river were noted. For the months of Jan. through Apr., separate means, standard deviations, and distributions of the surface ice concentration were determined for periods when the ice arch was present or absent. The existence of the ice arch can be predicted by a simple indicator based on air temperature. The statistical distributions of ice concentration are strongly influenced by the presence or absence of the ice arch. The overall mean surface ice concentration was 9.5% with an arch present and 27.3% with no arch. Based on this finding, ice passage can be forecast.

MP 3077
ANALYSIS OF RIVER ICE MOTION NEAR A BREAKING FRONT.
Ferrick, M.G., et al, *Canadian journal of civil engineering,* Feb. 1992, 19(1), p.105-116, With French summary. 9 refs. For another source see 46-1871.
Weyrick, P.B., Hunnewell, S.T.
46-3615
RIVER ICE, HYDRODYNAMICS, ICE MECHANICS, ICE BREAKUP, BOUNDARY LAYER, ICE WATER INTERFACE, DYNAMIC PROPERTIES, WAVE PROPAGATION, ANALYSIS (MATHEMATICS).

Dynamic river ice breakup displays different behaviors depending on the physical characteristics of the river, the flow, and the ice cover. Although a quantitative theory of dynamic breakup is not yet available, one of the essential components of such a theory will be a description of the ice motion near the breaking front. In this paper, an analysis of this motion for a specific case is developed. The analysis is generalized by allowing the speed of the breaking front to vary, and the parameters of the ice motion that are obtained represent different dynamic breakup behaviors that have been previously described. The results of the analysis include (i) the ice velocity, ice acceleration, and bank resistance at each point in a river reach as functions of time, (ii) the equilibrium ice velocity as a function of bank resistance and the ice velocity as a function of time for several initial and bank resistance conditions, and (iii) the time of ice motion, ice velocity, ice acceleration, and the convergence of the moving ice with distance from the breaking front. The measure of ice convergence quantifies the loss of surface area by the sheet required for ice continuity, and distinguishes the basic types of dynamic breakup.

MP 3078
RIM: RIVER ICE MANAGEMENT.
U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH, Sep. 1981, 33p.
46-2613
RIVER ICE, ICE CONTROL, ICE CONDITIONS, RESEARCH PROJECTS, TRANSPORTATION.

MP 3079
DESIGNING SMALL-BOAT HARBORS FOR ICE CONDITIONS.
U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH, [1985], 21p.
46-2607
PORTS, ICE CONTROL, ICE CONDITIONS.

MP 3080
MODEL FOR VERTICAL FRAZIL DISTRIBUTION.
Liou, C.P., et al, *Water resources research,* May 1992, 28(5), p.1329-1337, 30 refs.
Ferrick, M.G.
46-3723
FRAZIL ICE, ICE FORMATION, TURBULENT FLOW, WATER FLOW, BUOYANCY, ICE WATER INTERFACE, ICE MODELS, ICE STRUCTURE, ANALYSIS (MATHEMATICS), SUPERCOOLING.

In this paper, a model is presented for the evolution of frazil over depth and with time in a turbulent flow. The net upward migration due to buoyancy of the frazil is opposed by intermittent mixing induced by large energy-containing eddies. A surface renewal model is used to describe the effects of large eddy mixing. Parameters that represent an entire water body are obtained by averaging those of discrete water columns, using a probability density function. These parameters include the concentration profile, the surface age, and the surface layer thickness. A dimensionless surface renewal frequency characterizes the frazil distribution at equilibrium. The rate of heat loss from the water surface, the surface renewal frequency, and the critical surface layer thickness determine whether the frazil will evolve toward a well-mixed equilibrium state or a layered state. The model provides a physical basis for understanding the transition between these states, consistent with existing empirical criteria and field data.

MP 3081
DIELECTRIC CONSTANT OF ICE AT 26.5-40 GHZ.
Koh, G., *Journal of applied physics,* May 15, 1992, 71(10), p.5119-5122, 7 refs.
46-3728
ICE PHYSICS, RADIATION ABSORPTION, ICE ELECTRICAL PROPERTIES, DIELECTRIC PROPERTIES, MICROWAVES, WAVE PROPAGATION, ATTENUATION, REMOTE SENSING, ELECTRICAL MEASUREMENT.

The complex dielectric constant, epsilon=epsilon'+i epsilon", of ice at 26.5-40 GHz was determined using free-space measurement technique. A network analyzer-based system was used to measure the phase velocity and attenuation of a synthesized pulse propagating in bubble-free ice which was grown from distilled de-ionized water. Based on the phase velocity measurement, epsilon' was determined to be 3.155 and virtually independent of frequency. The loss factor in ice was observed to be frequency dependent so that epsilon" increased from approximately 0.002 at the lower frequencies to 0.004 at the higher frequencies. No temperature dependence of epsilon' and epsilon" was observed at ice temperatures of -2.5 and -15 C.

MP 3082
DIELECTRIC PROPERTIES OF WET AND DRY SNOW, 50 HZ-100 KHZ.
Camp, P.R., et al, Physics and chemistry of ice. Edited by N. Maeno and T. Hondoh, Sapporo, Japan, Hokkaido University Press, 1992, p.156-162, 6 refs.
Labrecque, D.R.
46-3851
WET SNOW, SNOW ELECTRICAL PROPERTIES, SNOW WATER CONTENT, DIELECTRIC PROPERTIES, SNOWMELT, ELECTRICAL RESISTIVITY.

Little information is available concerning the dielectric properties of wet or dry snow in the frequency range of the Debye dispersion in ice. This spectral region is interesting because here the dielectric behavior of the ice grains changes rapidly. Samples of six different snowstorms have been gathered and stored under similar conditions. Meltwater has been analyzed for conductivity, pH, and various ionic impurities. Dielectric properties have been measured for these snows, both dry and with various water contents. Water content was changed with minimum disturbance of the sample by melting a portion of the sample in place using resistive heating at 20 kHz.

MP 3083
MEASUREMENT OF DYNAMIC FRICTION OF ICE.
Itagaki, K., et al, Physics and chemistry of ice. Edited by N. Maeno and T. Hondoh, Sapporo, Japan, Hokkaido University Press, 1992, p.212-218, 8 refs.
Huber, N.P.
46-3860
ICE FRICTION, ICE SURFACE, SURFACE ROUGHNESS, SLEDS, ICE METAL FRICTION, MECHANICAL TESTS.

A series of friction measurements was made between a rotating ice cylinder and bobsled runners of various roughness. The friction increased to a maximum and then dropped.

MP 3084
MATHEMATICAL MODEL ON THE STEADY GROWTH OF AN ICE LAYER IN FREEZING SOILS.
Nakano, Y., Physics and chemistry of ice. Edited by N. Maeno and T. Hondoh, Sapporo, Japan, Hokkaido University Press, 1992, p.364-369, 14 refs.
46-3883
SOIL FREEZING, FROZEN GROUND THERMODYNAMICS, ICE GROWTH, FREEZING FRONT, SOIL WATER MIGRATION, MATHEMATICAL MODELS.

Recently, three distinct and representative hypotheses on the properties of the frozen fringe were evaluated mathematically and experimentally for a special case where the steady growth of an ice layer occurs in freezing soils. It was found that a hypothesis based on the independence of temperature and unfrozen water pressure in the frozen fringe was consistent with empirical data. The properties of the mathematical solution to the problem of steady growth of an ice layer under this hypothesis are presented.

MP 3085
EFFECT OF WIND ON FM-CW RADAR BACKSCATTER FROM A WET SNOWCOVER.
Koh, G., *IEEE transactions on geoscience and remote sensing,* May 1992, 30(3), p.619-621, 9 refs.
46-4067
SNOW COVER, RADAR ECHOES, BACKSCATTERING, SNOW WATER CONTENT, WET SNOW, SNOW EVAPORATION, WIND FACTORS, MICROWAVES, SNOW AIR INTERFACE.

The most important factor affecting the microwave properties of a snowcover is the liquid water content (snow wetness). An FM-CW (26.5-40 GHz) radar has been used to investigate the influence of snow wetness on the magnitude of radar

backscatter from a snowcover. The radar backscatter measurements from a wet snowcover on a windy day suggest that evaporative cooling due to the wind may reduce the amount of liquid water at the snowcover surface.

MP 3086
SNOW DISTRIBUTION AND HEAT FLOW IN THE TAIGA.
Sturm, M., *Arctic and alpine research,* May 1992, 24(2), p.145-152, 22 refs.
46-3974
TAIGA, SNOW COVER DISTRIBUTION, SNOW COVER EFFECT, FOREST CANOPIES, HEAT LOSS, TREES (PLANTS), TOPOGRAPHIC EFFECTS, SOIL TEMPERATURE, WATER STORAGE, WATERSHEDS.
The taiga forest covers vast areas of Alaska, Canada, Siberia, and Scandinavia. Winter lasts 6 to 8 months of the year, so the forest is snow covered more often than not. The trees of the forest intercept falling snow and cause it to become distributed in an uneven fashion. Beneath spruce trees (conifers), the snow cover is depleted and a bowl-shaped depression (a tree well) forms. Around aspen and birch (deciduous trees), a cone-shaped accumulation of snow forms. Postdepositional metamorphic processes accentuate this irregular snow distribution. The snow cover, in its undisturbed state, insulates and protects the underlying ground from the extremely low temperatures that occur during the boreal winter. However, this protection can be less effective when the snow cover has been modified by the trees. In this paper, the distribution of snow beneath the trees of the taiga forest is examined, and the effect of the uneven distribution on the winter heat loss from the ground is discussed.

MP 3087
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY (CRREL).
Itagaki, K., *Seppyo,* Sep. 1991, 53(3), p.231-233, In Japanese.
46-1316
LABORATORIES, ORGANIZATIONS, RESEARCH PROJECTS.

MP 3088
REVIEW, ANALYSIS AND VALIDATION OF SNOW-ONE-A TRANSMISSION DATA.
Gallery, W.O., et al, Ann Arbor, MI, OptiMetrics, Inc., July 1985, 83p. + append., 15 refs.
46-3991
SNOWFALL, SNOW OPTICS, ATMOSPHERIC ATTENUATION, VISIBILITY, SNOWSTORMS, MILITARY RESEARCH, METEOROLOGICAL INSTRUMENTS, INFRARED RECONNAISSANCE, ANALYSIS (MATHEMATICS).

MP 3089
THEORETICAL HEIGHTS OF BUOYANT CONVECTION ABOVE OPEN LEADS IN THE WINTER ARCTIC PACK ICE COVER.
Serreze, M.C., et al, *Journal of geophysical research,* June 15, 1992, 97(C6), p.9411-9422, 39 refs.
Maslanik, J.A., Rehder, M.C., Schnell, R.C., Kahl, J.D., Andreas, E.L.
46-4130
ATMOSPHERIC PHYSICS, POLYNYAS, AIR FLOW, CONVECTION, AIR TEMPERATURE, SEA ICE, ICE COVER EFFECT, BOUNDARY LAYER, BUOYANCY, TEMPERATURE INVERSIONS.
A fetch-dependent boundary-layer model, driven by observed temperature sounding data, is used to examine theoretical heights of buoyant convection *(H)* above open leads in the wintertime pack ice of the central Arctic. Assuming wet adiabatic ascent with no entrainment or friction, *H* is estimated as the height at which the model-predicted equivalent potential temperature at saturation above a lead intersects with the same value of equivalent potential temperature at saturation derived from vertical sounding profiles. *H* increases with increasing lead width. For a 1000 m lead, the widest which can be reasonably expected for the central Arctic, the median value of *H* is approximately 1000 m, slightly below the median top of the low-level arctic temperature inversion layer. While *H* shows large variability, events of convection up to 4 km, as recently observed from lidar backscatter data, appear to be fairly rare. First, these events require an open lead of least 10,000 m. Second, while *H* tends to be largest under conditions of low surface wind speed, low surface temperature, and a weak low-level temperature inversion, this combination appears to be atypical of arctic conditions. Third, while the meteorological conditions that should favor the development of open leads tend to minimize *H,* conditions favoring large *H* are also those in which any newly developed leads will quickly ice over.

MP 3090
PROCEEDINGS. VOL.4.
International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992, New York, American Society of Mechanical Engineers, 1992, 422p., Refs. passim. For selected papers see 46-4133 through 46-4185.
Ayorinde, O.A., ed, Sinha, N.K., ed, Sodhi, D.S., ed, Nixon, W.A., ed.
46-4132
ICE COVER STRENGTH, ICE LOADS, ICE DEFORMATION, OFFSHORE STRUCTURES, PERMAFROST PRESERVATION, ICE BREAKING, ICE PRESSURE, SEA ICE, FOUNDATIONS, SOIL STRENGTH, SOIL PRESSURE, ICE SOLID INTERFACE.

MP 3091
THERMAL DESIGN IN PERMAFROST REGIONS.
Zarling, J.P., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.113-121, 22 refs.
Haynes, F.D., Lunardini, V.J.
46-4147
PERMAFROST THERMAL PROPERTIES, PERMAFROST PRESERVATION, FOUNDATIONS, SOIL AIR INTERFACE, COOLING SYSTEMS, HEAT PIPES, DUCTS, PERMAFROST BENEATH STRUCTURES, THERMAL ANALYSIS, ANALYSIS (MATHEMATICS), SOIL TEMPERATURE.
The essential thermal analyses required for foundation design in permafrost regions are presented. Equations are given for calculating the ground surface temperature and the temperature variation in the soil. Foundation designs on piles and on grade are discussed and design methods presented.

MP 3092
ASSESSMENT OF PREDICTION METHODS FOR THE THICKNESS OF THE ACTIVE LAYER IN PERMAFROST REGIONS.
Aziz, A., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.131-138, 13 refs.
Lunardini, V.J.
46-4148
PERMAFROST THERMAL PROPERTIES, ACTIVE LAYER, THAW DEPTH, PERMAFROST HEAT TRANSFER, SOIL AIR INTERFACE, SOIL TEMPERATURE, ANALYSIS (MATHEMATICS), PERMAFROST FORECASTING.
Four methods of predicting the thickness of the active permafrost layer when the annual surface temperature variation follows a sinusoidal pattern are discussed: (1) a generalized Stefan method which incorporates the thawing index; (2) a two-region Neumann solution in which an equivalent constant surface temperature is used to simulate the sinusoidal variation; (3) a coupled integral equations approach; and (4) a two-term perturbation solution. The predictions of the Neumann and the perturbation solutions are closest to the finite element results, being within 1%. However, the perturbation method may be more useful in predicting the temperature variations in the active layer with time.

MP 3093
LABORATORY TESTS WITH A 37-M THERMOSYPHON IN SOIL.
Haynes, F.D., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.139-143, 14 refs.
Zarling, J.P., Gooch, G.E., Zabilansky, L.
46-4149
PERMAFROST PRESERVATION, FOUNDATIONS, HEAT PIPES, PERMAFROST BENEATH STRUCTURES, COOLING SYSTEMS, HEAT TRANSFER, PERMAFROST THERMAL PROPERTIES, CONDUCTION.
Tests were conducted in the laboratory with a 37 m-long thermosyphon buried in soil to simulate actual field conditions. The evaporator section was horizontal and the finned condenser section was vertical. The thermosyphon had a device to return part of the condensate to the far end of the evaporator. Unit conductance values were obtained for wind speeds ranging from 0 to 2.4 m/s directed at the condenser section. These conductance values were used in a finite element analysis to determine if they were adequate for foundation design in permafrost regions.

MP 3094
FLOATING ICE BEAM IMPACT AGAINST A SLOPED STRUCTURE.
Coutermarsh, B.A., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.173-181, 8 refs.
McGilvary, W.R., Sodhi, D.S.
46-4155
ICE LOADS, OFFSHORE STRUCTURES, ICE FLOES, BRIDGES, IMPACT TESTS, ICE DEFORMATION, ICE FRICTION, ICE PRESSURE, ICE SOLID INTERFACE, MATHEMATICAL MODELS.
Experiments were performed to measure the impact forces generated by free-floating ice beams striking a 45 deg sloped structure. Four beam lengths and impact velocities are used with a fixed beam width and thickness. A coupled fluid/solid finite element program was developed to model the impulse loads. The structure is modeled as a massless surface that can displace horizontally and vertically without rotation. The solid mechanics portion of the modelled ice is based on linear elastic beam theory, and includes rotary inertia and a static fluid foundation. The fluid dynamic portion assumes linear fluid inertial coupling for the fluid foundation. A fluid influence coefficient matrix is calculated and attached to the ice to account for the fluid foundation acceleration. The numerical model matches the experimental peak impact forces to within 10% to 33% for the majority of the beam lengths. The shortest beams considered appear to behave differently, and those experimental values were overpredicted by a factor of 2. Improvements in the predictions could be realized by including a mechanism for energy loss from the beam to the supporting fluid. The work also shows that structure stiffness greatly affects the impact force in ice/structure interactions.

MP 3095
INDENTATION TESTS USING UREA ICE AND SEGMENTED INDENTORS.
Sodhi, D.S., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.223-230, 16 refs.
Chin, S.N.
46-4160
ICE LOADS, ICE COVER STRENGTH, ICE PRESSURE, ICE DEFORMATION, ICE BREAKING, UREA, ARTIFICIAL ICE, ICE MODELS, IMPACT TESTS, STRAIN TESTS.
Segmented indentors were used to conduct indentation tests using urea model ice. Each segment of an indentor was supported on three load cells to enable measurement of force generated in that segment as a result of interaction with ice. Tests were conducted using 3, 5 or 7 segments. The range of ice thickness was between 40 and 81 mm, and the rate of indentation was between 2 and 400 mm/s. The results are presented as time-history plots of forces across each segment as well as the whole width of an indentor. The main result of these tests is that the effective pressure measured during tests at a low indentation rate was higher than that at high indentation rate. The force-time plots indicate that there was simultaneous failure of ice on all segments at low indentation rates, and that there was nonsimultaneous failure of ice at high rates of indentation. This behavior is attributed to brittle, flaking failure at high indentation rates. Spectral analysis of force data indicates that most of the power is contained at frequencies of less than 5 Hz. The peaks in the ice force records fit a Weibull probability distribution.

MP 3096
COMPOSTING PROCESS, DESIGN AND ANALYSIS IN COLD CLIMATE.
Ayorinde, O.A., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.409-413, 11 refs.
Reynolds, C.M.
46-4184
SOIL POLLUTION, WASTE TREATMENT, EXPLOSIVES, ROOFS, SNOW LOADS, COLD WEATHER PERFORMANCE, MILITARY FACILITIES, THERMAL ANALYSIS, HEAT TRANSFER, DECOMPOSITION, MATHEMATICAL MODELS.
Composting has been investigated and field-demonstrated at the Louisiana Army Ammunition Plant (LAAP) by the Toxic and Hazardous Materials Agency of the U.S. Army Corps of Engineers as an alternative method of decontaminating explosives-contaminated soils and sediments in a warm environment. Soils and sediments were contaminated with explosive residues as a result of the manufacture, use and disposal of organic-based explosives at military bases and U.S. Army ammunition plants. A preliminary analysis was performed to evaluate the applicability of the LAAP

warm-temperature compost design and operation methods to cold environment composting. The results of the analysis were quantitatively compared with the field observations of the winter compost operation at the Badger Army Ammunition Plant (BAAP) in Baraboo, WI.

MP 3097
THERMAL AND HYDRAULIC ANALYSIS OF A CHILLED PIPELINE RIVER CROSSING.
McGilvary, W.R., et al, International Conference on Offshore Mechanics and Arctic Engineering, 11th, Calgary, Alberta, June 7-12, 1992. Proceedings. Vol.4. Edited by O.A. Ayorinde, N.K. Sinha, D.S. Sodhi, and W.A. Nixon, New York, American Society of Mechanical Engineers, 1992, p.415-420, 13 refs.
Carlson, R.F.
46-4185
UNDERGROUND PIPELINES, PIPELINE FREEZING, SOIL FREEZING, RIVER CROSSINGS, HEAT TRANSFER, FROZEN GROUND THERMODYNAMICS, ICE ACCRETION, ICE GROWTH, SOIL STABILIZATION, SOIL PRESSURE, MATHEMATICAL MODELS.
A buried, chilled pipeline surrounded by seeping groundwater is analyzed. The pipe is assumed to be located within a convection cell with the surface water temperature varying throughout the year. The volume and moment of the freeze bulb on the pipe are presented as functions of time. The heat transferred to the pipe is also presented. The pipe is assumed to be unable to move independently of the freeze bulb, and estimates of the maximum static horizontal and vertical forces transferred from the freeze bulb to the pipe are presented. Seismic forces associated with acceleration of the pipe and freeze bulb are not discussed in detail, although these may be significant. The accreted ice and soil mass is shown to attain a nearly symmetric shape in wintertime. For the cases investigated, the freeze bulb extends to the stream bed, which may lead to the formation of a dam, either by extension of the freeze bulb itself or by the capture of frazil ice. Upstream scour around the freeze bulb also may be a problem. In addition, there may be environmental impacts on local habitat. If the stream runs dry in the winter, aufeis may form. In the summer, melting at the upstream portion of the freeze bulb leads to an asymmetric "teardrop" shape that gives the frozen mass a significant moment about the pipe center. The freeze bulb diminishes in size and more heat is transferred to the pipe in summer than in winter.

MP 3098
SNOW AND GLACIER MAPPING IN ALPINE REGIONS WITH POLARIMETRIC SAR.
Shi, J.C., et al, International Geoscience and Remote Sensing Symposium (IGARSS '91), Espoo, Finland, Helsinki University of Technology, June 3-6, 1991. [Proceedings]. Remote sensing: global monitoring for Earth management, Vol.4, New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p.2311-2314, 14 refs.
Dozier, J., Rott, H., Davis, R.E.
46-4266
REMOTE SENSING, MAPPING, MICROWAVES, SYNTHETIC APERTURE RADAR, SNOW COVER DISTRIBUTION, GLACIERS, CLASSIFICATIONS, ANALYSIS (MATHEMATICS).
The objective of this study is to examine the capability of mapping snow and glacier in alpine regions using SAR radar imagery when topographic information is not available. The topographic effects on the received power for a resolution cell can be explained by the change in an illumination area and an incidence angle in a slant-range representation of SAR imagery. The specific polarization signature has been found to be relatively independent of both illumination area and incidence angle for a pixel resolution, and provides a suitable measurement data set for snow and glacier mapping in a high relief area. The results show that the C-band images of the enhancement factor, which is the ratio of synthesized image to the total power, provide the capability of discrimination between snow, glacier and rock regions.

MP 3099
ALKALINITY MEASUREMENTS IN WATER EXTRACTS OF CALCAREOUS SOILS.
Marion, G.M., et al, *Soil Science Society of America. Journal,* Mar.-Apr. 1992, 56(2), p.598-600, 18 refs.
Schlesinger, W.H., Fonteyn, P.J.
46-4293
SOIL CHEMISTRY, SOIL COMPOSITION, SOLUBILITY, SOIL TESTS.
In soil carbonate solubility studies, it is usually assumed that total alkalinity is equal to inorganic-C alkalinity. Recent studies have raised questions about the validity of this assumption. This study reexamined previously published soil data from grass-oak *(Quercus* spp.) woodlands and deserts to test the hypothesis that total alkalinity is equal to inorganic-C alkalinity. Total alkalinity was measured with strong-acid titration, while inorganic-C alkalinity was calculated from pH and the partial pressure of CO2 (pCO2) measurements. Within the limits of error, calculated inorganic C alkalinity was equal to measured total alkalinity. A recommendation was made for overdetermining the state of experimental systems in solubility studies; this allows one to check the internal consistency of experimental measurements, equilibrium constants, and model assumptions.

MP 3100
CONFINED COMPRESSIVE STRENGTH OF HORIZONTAL FIRST-YEAR SEA ICE SAMPLES.
Richter-Menge, J.A., *Journal of offshore mechanics and arctic engineering,* Nov. 1991, Vol.113, p.344-351, 30 refs. For another version see 41-2422.
46-4294
ICE COVER STRENGTH, ICE PRESSURE, ICE DEFORMATION, STRAIN TESTS, COMPRESSIVE PROPERTIES, SEA ICE, ICE LOADS.
A total of 110 first-year sea ice samples from Prudhoe Bay, AK, were tested in unconfined and confined constant strain rate compression. All of the tests were performed in the laboratory on a closed-loop electrohydraulic testing machine at -10 C. The confined tests were performed in a conventional triaxial cell (sigma1>sigma2=sigma3) that maintained a constant ratio between the radial and axial stress (sigma2/sigma1=constant) to simulate true loading conditions. Three strain rates (.01, .001, and .00001/s) and three sigma2/sigma1 ratios (0.25, 0.50, and 0.75) were investigated. This paper summarizes the field sampling and testing techniques and presents data on the effect of confinement on the compressive strength, initial tangent modulus, and failure strain of the ice.

MP 3101
MEASUREMENT OF HEAT LOSSES FROM HOT WATER HEAT DISTRIBUTION SYSTEMS.
Phetteplace, G.E., International District Heating and Cooling Association, 83rd Annual Meeting, Danvers, MA, June 12-17, 1992. Proceedings, Washington, D.C., 1992, p.301-315, 12 refs.
46-4295
HEAT LOSS, RADIANT HEATING, HEAT TRANSFER, WATER PIPES, STEAM, MILITARY FACILITIES, COST ANALYSIS.
This paper describes two field projects underway at U.S. Army bases. At Fort Jackson, SC, a medium-temperature hot water heat distribution system is being monitored. Three different types of system constructions have been instrumented: pipes enclosed in a shallow concrete trench, steel conduit with supply and return pipes in common conduit, and separate steel conduits for supply and return pipes. At Ft. Irwin, CA, a low-temperature hot water system is being monitored. Two sites have been instrumented on this direct buried system that consists of steel carrier pipes insulated with polyurethane foam protected by a fiberglass jacket. The heat losses from these systems are being monitored.

MP 3102
ENGINEERING ASPECTS OF METAL-WASTE MANAGEMENT.
Iskandar, I.K., ed, Chelsea, MI, Lewis Publishers, 1992, 231p., Proceedings of a workshop that was part of the International Conference on Metals in Soils, Waters, Plants, and Animals, Orlando, FL, Apr. 30-May 3, 1990. Refs. passim. For selected paper see 46-4338.
Selim, H.M., ed.
46-4337
WASTE TREATMENT, SOIL POLLUTION, SOIL CHEMISTRY, METALS, SOIL MICROBIOLOGY, STATISTICAL ANALYSIS, MATHEMATICAL MODELS.

MP 3103
MICROWAVE DIGESTION PROCEDURES FOR CHARACTERIZING METAL CONTAMINATED SOILS: APPLICATIONS, LIMITATIONS AND PROJECTED CAPABILITIES.
Reynolds, C.M., Engineering aspects of metal-waste management. Edited by I.K. Iskander and H.M. Selim, Chelsea, MI, Lewis Publishers, 1992, p.49-61, 50 refs.
46-4338
SOIL POLLUTION, SOIL CHEMISTRY, METALS, SOIL TESTS, CHEMICAL ANALYSIS, MICROWAVES.

MP 3104
ARCTIC RESEARCH OF THE UNITED STATES, VOL.6.
U.S. Interagency Arctic Research Policy Committee, Washington, D.C., Spring 1992, 136p.
Myers, C.E., ed, Bowen, S., ed, Cate, D.W., ed, Valliere, D.R., ed.
46-4381
RESEARCH PROJECTS, ORGANIZATIONS, LEGISLATION, COST ANALYSIS, INTERNATIONAL COOPERATION, MEETINGS.

MP 3105
LOW-TEMPERATURE WATER FOR HEAT DISTRIBUTION SYSTEMS.
Phetteplace, G.E., United States Army Corps of Engineers Electrical and Mechanical Engineering Conference, Dallas, TX, July 14-17, 1992, Dallas, 1992, p.139-145, 6 refs.
46-4383
RADIANT HEATING, WATER PIPES, HEAT TRANSFER, HEAT LOSS, MILITARY FACILITIES, COST ANALYSIS.

MP 3106
U.S. RESEARCH IN ICE MECHANICS: 1987-1990.
Richter-Menge, J.A., *Cold regions science and technology,* June 1992, 20(3), p.231-246, Refs. p.242-246.
46-4443
ICE MECHANICS, SEA ICE, RESEARCH PROJECTS, BIBLIOGRAPHIES, ICE SOLID INTERFACE, ICE MODELS, MECHANICAL PROPERTIES, MICROSTRUCTURE, MECHANICAL TESTS.
This compilation of U.S. ice mechanics investigations over 1987-1990 focuses on efforts that support the development of an understanding of sea ice interaction. Both ice-structure and ice-ice interaction studies have been included in hopes that insights from one area will complement developments in the other. The work discussed in the area of ice-structure interaction was intentionally limited to lateral movement of the ice against a vertical structure. It is these results that can be most easily extended to ice-ice interaction events.

MP 3107
PERFORMANCE OF A THERMOSYPHON WITH A 37 METER-LONG, HORIZONTAL EVAPORATOR.
Haynes, F.D., et al, *Cold regions science and technology,* June 1992, 20(3), p.261-269, 12 refs.
Zarling, J.P., Gooch, G.E.
46-4445
PERMAFROST PRESERVATION, TEMPERATURE CONTROL, PIPES (TUBES), REFRIGERATION, SIMULATION, PERMAFROST HEAT TRANSFER, THERMAL CONDUCTIVITY, COLD WEATHER PERFORMANCE, SOIL STABILIZATION, DESIGN, ICE GROWTH, HEAT SINKS.
Laboratory tests were conducted on a thermosyphon with a 37 m long horizontal evaporator. This evaporator section was placed in a water tank so that the rate of ice growth on it could be determined. Unit conductance values were calculated for wind speeds of 0 to 5.4 m/s applied to the condenser section. Use of these conductance values in a finite element analysis indicated that thermosyphons with horizontal evaporators and condensate return devices were adequate for many foundation designs in permafrost regions.

MP 3108
SEAFLOOR TEMPERATURE AND CONDUCTIVITY DATA FROM STEFANSSON SOUND, ALASKA.
Sellmann, P.V., et al, *Cold regions science and technology,* June 1992, 20(3), p.271-288, 11 refs.
Delaney, A.J., Chamberlain, E.J., Dunton, K.H.
46-4446
OCEAN BOTTOM, LIQUID SOLID INTERFACES, BOTTOM SEDIMENT, FREEZING POINTS, WATER TEMPERATURE, SALINITY, TEMPERATURE MEASUREMENT, ELECTRICAL RESISTIVITY, SUBSURFACE INVESTIGATIONS, SOIL COMPACTION, SEASONAL VARIATIONS.
Overconsolidated sediments, seasonal seafloor freezing, and ice-bonded permafrost, unique features in shallow arctic coastal waters, are related to low seawater temperatures and varying salinities. Seabed temperatures can be less than - 1.0 C for much of the year, with noticeable warming occurring only during the summer months. Observations from recent deployment of three instruments in Stefansson Sound and data from an earlier deployment, which included sites in Harrison Bay, showed decreasing mean annual seafloor temperatures with increasing water depth, ranging from -0.9 C in 4.4 m of water to -1.6 C in 14 m of water. Salinities also varied seasonally, with noticeable freshening developing during the summer and high uniform values occurring during the winter. Periodic temperature and salinity measurements at sites in Stefansson Sound, made during Aug. 1987 and Aug. 1989, also helped verify the data obtained with the seabottom instruments. Seasonal freezing of the seabed can begin in late September and may noticeably change its engineering properties. In areas of coarse-grained sediments, ice bonding and strengthening of the seabed can result. In areas of fine-grained sediments it appears that seasonal freezing of the seafloor can cause overconsolidation of the seabed sediments. This densification process can result in a significant permanent increase in strength.

MP 3109
CONSTRUCTION IN AREAS OF EXTREME CLIMATIC AND COMPLEX GEOLOGICAL CONDITIONS. Office of the Chief of Engineers, U.S. Army Corps of Engineers, 6 Apr. 1986, 91p., Meeting of Working Group 10.5 of the U.S./U.S.S.R. Joint Commission on Cooperation in the Field of Housing and Other Construction, 10-20 March 1986, Leningrad and Yakutsk, U.S.S.R.
46-3527
MEETINGS, INTERNATIONAL COOPERATION, COLD WEATHER CONSTRUCTION, FOUNDATIONS, BUILDINGS, PERMAFROST BENEATH STRUCTURES, CONCRETE PILES, PILE LOAD TESTS.

MP 3110
NUMERICAL SIMULATIONS OF A COMPACT CONVERGENT SYSTEM OF ICE FLOES.
Hopkins, M.A., et al, *Annals of glaciology,* 1991, Vol.15, Symposium on Ice-Ocean Dynamics and Mechanics, Hanover, NH, Aug. 26-31, 1990. Proceedings, p.26-30, 7 refs.
Hibler, W.D., III.
46-1708
ICE FLOES, ICE DEFORMATION, DRIFT, ICE MECHANICS, PACK ICE, ICE FRICTION, ICE MODELS, MATHEMATICAL MODELS.

MP 3111
ON THE RIDGING OF A THIN SHEET OF LEAD ICE.
Hopkins, M.A., et al, *Annals of glaciology,* 1991, Vol.15, Symposium on Ice-Ocean Dynamics and Mechanics, Hanover, NH, Aug. 26-31, 1990. Proceedings, p.81-86, 9 refs.
Hibler, W.D., III.
46-1715
PRESSURE RIDGES, ICE DEFORMATION, ICE OPENINGS, SEA ICE, MATHEMATICAL MODELS, ICE MODELS, ICE FLOES.

MP 3112
EXPERIMENTAL FRACTURE MECHANICS OF ASPHALTIC CONCRETES IN THE LINEAR ELASTIC REGIME.
Jiménez Hamann, F.N., Worcester, MA, Worcester Polytechnic Institute, 1992, 61p., M.S. thesis. 16 refs.
46-4520
CONCRETE PAVEMENTS, CONCRETE STRENGTH, CONCRETE FREEZING, BITUMINOUS CONCRETES, FROST RESISTANCE, CRACKING (FRACTURING), COLD STRESS, STRAIN TESTS.

MP 3113
SEA SPRAY AND THE TURBULENT AIR-SEA HEAT FLUXES.
Andreas, E.L., *Journal of geophysical research,* July 15, 1992, 97(C7), p.11,429-11,441, 76 refs.
46-4553
SEA SPRAY, AIR WATER INTERACTIONS, AIR TEMPERATURE, DROPS (LIQUIDS), HEAT FLUX, TURBULENT BOUNDARY LAYER, MOISTURE TRANSFER, ANALYSIS (MATHEMATICS), WIND FACTORS, CLOUD PHYSICS.
Heat and moisture carried by sea spray have long been suspected of contributing to the air-sea fluxes of sensible and latent heat. Using time scales that parameterize how long sea spray droplets reside in the air and how quickly they exchange heat and moisture with their environment, the author estimates sea spray contributions to the air-sea heat fluxes. To make these estimates, a new sea spray generation function that predicts more realistic spume production than earlier models is developed. Spray droplets with initial radii between 10 and 300 microns contribute most to the heat fluxes; the vast majority of these are spume droplets. The modeling not only demonstrates how spray droplets participate in the air-sea heat exchange but also confirms earlier predictions that the heat carried by sea spray (especially the latent heat) is an important component of the air-sea heat balance. In cited examples, the maximum magnitude of the spray latent heat flux for a 20 m/s wind is 170 W/sq m; the maximum spray sensible heat flux is 33 W/sq m. For winds over 10 m/s, the spray latent heat flux is usually a substantial fraction of the interfacial (or turbulent) latent heat flux (estimated from the bulk-aerodynamic equations), and will thus confound measurements of the air-sea transfer coefficient for latent heat.

MP 3114
GROWTH, STRUCTURE AND PROPERTIES OF ANTARCTIC SEA ICE.
Ackley, S.F., *IAHS publication,* 1991, No.208, Glaciers-ocean-atmosphere interactions. Edited by V.M. Kotliakov, A. Ushakov, and A. Glazovskiĭ, p.105-117, 20 refs.
46-4610
SEA ICE, PACK ICE, ICE GROWTH, ICE STRUCTURE, ICE COVER THICKNESS, AIR ICE WATER INTERACTION, ICE EDGE, DRIFT, FRAZIL ICE, ANTARCTICA—WEDDELL SEA.
The Weddell Gyre region is one of the more complex areas of sea ice processes in Antarctica. In the western part of the region, the pack ice persists year-round, caused by a vigorous generation and circulation of the ice, controlled by the atmospheric and ocean current forcing that is turned northward by the topographic boundary of the Antarctic Peninsula. The dynamical character of the pack ice affects the ice thickness characteristics, with the oldest, thickest ice appearing in the northwest outflow region of the western pack ice. In the eastern part, the pack is seasonal rather than perennial. The primary origin of the pack ice (0.6 m of mean ice thickness) is the rapid formation of pancake ice, controlled by the temperature and ocean wave regime at the ice edge during the advance period. (Auth.)

MP 3115
ENGINEERING DESIGN CHOICES FOR GREAT LAKES SMALL CRAFT HARBORS USING A WINTER CONDITIONS CLASSIFICATION SYSTEM.
Wortley, C.A., IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.1, 1992, p.41-48, 3 refs.
46-4917
PORTS, COLD WEATHER OPERATION, ICE CONTROL, LAKE ICE, ICE CONDITIONS, DOCKS, SITE SURVEYS, DATA PROCESSING.
To aid designers in selecting among choices for the design of docks and other harbor structures, a winter Conditions Classification System was presented at the 10th Ice Symposium. The conditions are ice thickness, water level fluctuation, water and air temperatures, winter duration, snowfall, ice sheet confinement and integrity, and miscellaneous site specific conditions. The classifications are mild, average and severe, and represent conditions that range between not too significant to very significant for design purposes. This paper presents a matrix of design choices which correspond with classified winter conditions at a given site. The small craft harbor design elements are: structural dockage systems, floating dockage systems, and removable dockage systems supplemented by ice control measures. Making the best engineering design choices for given winter conditions will result in safe, economical and long-lasting small craft harbor facilities.

MP 3116
FIELD TEST OF A SURFACE-HEATED TRASH RACK TO PREVENT FRAZIL ICE BLOCKAGE.
Daly, S.F., et al, IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.1, 1992, p.71-77, 8 refs.
Haynes, F.D., Garfield, D.E., Clark, C.H.
46-4920
RIVER ICE, FRAZIL ICE, ICE PREVENTION, WATER INTAKES, ELECTRIC POWER, ELECTRIC HEATING.
The concept of heating only the leading edge of trash rack bars to efficiently prevent frazil ice blockage has been investigated. Proof-of-concept tests conducted in a laboratory flume proved to be successful in preventing blockage by frazil ice. A field test was then made at a small (143-kw) hydro plant. This field test was successful in greatly reducing frazil ice blockage. The total electrical power supplied was only 2.8 kw, or 0.26 kw/sq ft.

MP 3117
DYNAMIC ANALYSIS OF ICE FLOE UNDERTURNING STABILITY.
McGilvary, W.R., et al, IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.1, 1992, p.489-502, 10 refs.
Coutermarsh, B.
46-4958
RIVER ICE, RIVER FLOW, ICE WATER INTERFACE, ICE COVER EFFECT, ICE FLOES, ICE COVER STRENGTH, ICE BOTTOM SURFACE, WATER PRESSURE, ICE CONTROL, ICE MODELS, MATHEMATICAL MODELS.
In order to estimate the ice floe capture efficiency of a river ice cover, an underturning stability criteria is required for each characteristic floe geometry. In the current work, the measured hydrodynamic pressure distribution on the bottom of a single model ice floe is used to estimate the dynamic stability at three thickness to depth ratios. The energy-based analysis details the conditions required for instability, metastability, and stability. The results are shown to compare favorably to existing stability criteria. At all three thickness to depth ratios, the effect of block rotational inertia has the effect of reducing the Froude number by 5% to 10% over a completely static stability criterion.

MP 3118
IN-SITU MEASUREMENT OF THE PERMEABILITY OF FRAZIL ICE.
White, K.D., et al, IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.2, 1992, p.622-632, 14 refs.
Lawson, D.E.
46-4969
FRAZIL ICE, RIVER ICE, ICE WATER INTERFACE, PERMEABILITY, SEEPAGE, BOTTOM ICE, BOREHOLES.
The intrinsic permeability of a frazil deposit can be used to describe its flow capacity and structure. Because of the nature of frazil ice, an in-situ test is desirable when determining this parameter in natural frazil deposits. This paper describes the application of a borehole dilution test to determine seepage velocity, which is then used to calculate intrinsic permeability and estimate porosity. Seepage velocities ranged from .00029 to .00598 cm/s (.00256 cm/s average), and average intrinsic permeability was .000275/sq cm. Porosities for d10 grain sizes of 0.5 and 3.5 mm were 82.9 and 47.9%, respectively. Seepage velocity and porosity data are also compared to data from laboratory borehole dilution tests, previous in-situ groundwater flow meter measurements at the same site, and permeameter tests on remolded samples.

MP 3119
ICE-STRUCTURE INTERACTION WITH SEGMENTED INDENTORS.
Sodhi, D.S., IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.2, 1992, p.909-929, 46 refs.
46-4991
ICE SOLID INTERFACE, ICE LOADS, ICE PRESSURE, ICE DEFORMATION, ICE COVER STRENGTH, IMPACT TESTS, PENETRATION TESTS, MATHEMATICAL MODELS.
Experimental work on ice-structure interaction is reviewed. The review includes small-scale and medium-scale indentation tests conducted to understand this interaction and to measure the effective pressures at different speeds and contact areas. Different modes of ice failure have been identified, such as ductile failure, ductile flaking and brittle flaking. Experiments to understand brittle flaking were conducted in the laboratory to observe the ice-structure interaction and to measure pressure in different parts of the indentor. It was found that the contact between the indentor and the ice failing during brittle flaking is over a small area of contact. Such small areas of contact were also observed in the ship-ice interaction. To compare results of indentation tests done at different scales, it is suggested that a similarity principle from "replica" modeling be adopted. In replica modeling, the indentation tests are done at a scale smaller than full-scale, using the same material and the same indentation speed as in full scale. Using this similarity principle, the effective pressure measured in small-scale indentation tests in freshwater ice is found to be in the range of pressures measured on large structures in the field.

MP 3120
OBSERVATIONS OF STRESS IN ARCTIC PACK ICE.
Perovich, D.K., et al, IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.2, 1992, p.979-990, 20 refs.
Jones, K.F., Tucker, W.B.
46-4994
PACK ICE, ICE LOADS, ICE DEFORMATION, ICE COVER STRENGTH, ICE PRESSURE, THERMAL STRESSES, STRAIN MEASURING INSTRUMENTS, MATHEMATICAL MODELS.
Measurements of ice stresses were made from Sep. through Nov. in first-year and multiyear sea ice in the Eastern Arctic ice pack. Observed stresses were typically less than 50 kPa, with peak values reaching 400 kPa in young ice and 150 kPa in the interior of a multiyear floe. The largest stresses were always observed in the upper half of the ice sheet. Three sources of ice stress were identified in the multiyear record: 1) stresses induced by temperature changes, 2) stresses resulting from inertial oscillations of the ice pack, and 3) stresses occurring during deformation events. Stresses in the first year ice were caused by inertial motions and by deformation. Under certain loading conditions, strong coupling was evident between the thin first-year ice and the adjacent multiyear floes, with stresses being greatest in the young ice and rapidly attenuating away from the floe edge in the multiyear ice. The stress field in the ice pack was complex and showed great spatial and temporal variability. A two- dimensional finite element model (ABAQUS) was used to interpret the point stress measurements and to estimate the stress distribution in the ice associated with unidirectional loading.

MP 3121
COMPRESSIVE STRENGTH OF FRAZIL SEA ICE.
Richter-Menge, J.A., IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.2, 1992, p.1065-1074, 12 refs.
46-5000
FRAZIL ICE, ICE COVER STRENGTH, ICE PRESSURE, ICE LOADS, SEA ICE, ICE DEFORMATION, COMPRESSIVE PROPERTIES, BRINES, STRAIN TESTS, ANTARCTICA—WEDDELL SEA.
Unconfined, uniaxial compressive strength tests were performed on frazil sea ice samples collected in the Weddell Sea. The tests were done at constant strain rates ranging from .01 to .00001/s and temperatures of -5 and -10 C. These conditions covered the brittle-to-ductile transition of this ice type. Results of the tests are presented and the compressive strength of the frazil samples is compared to the strength of transversely isotropic columnar saline ice loaded perpendicular to the growth direction. This analysis indicates that the strength of the frazil and columnar ice is comparable at a given porosity. The author discusses this finding with respect to the variations in the structural characteristics of each ice type. In particular, the influence of grain size and the spacing of brine inclusions are considered. (Auth.)

MP 3122
ICE PHYSICS AND MICROMECHANICS: A REVIEW OF SELECTED TOPICS.
Cole, D.M., IAHR Symposium on Ice, 11th, Banff, Alberta, Canada, June 15-19, 1992. Proceedings. Vol.2, 1992, p.1087-1099, 59 refs.
46-5002
ICE DEFORMATION, ICE PRESSURE, ICE CREEP, ICE CRACKS, ICE LOADS, ICE STRENGTH, ICE MICROSTRUCTURE, DISLOCATIONS (MATERIALS), INTERNAL FRICTION.
This paper focuses on recent theoretical and experimental developments in laboratory studies of ice physics and micromechanics. Topics of interest include progress in the observation and interpretation of dislocation-based processes and their relationship to mechanical behavior, electrical effects, microcrack nucleation, anelasticity, internal friction, creep and pressure effects. Recent experimental developments are discussed and their impact on current theories are evaluated. Relevant contributions include crack nucleation studies, techniques for reversed direct-stress testing, fatigue crack growth studies and the direct observation of dislocations. Research findings are assessed in terms of the insight they provide regarding the physical processes that underlie mechanical behavior. Areas where recent findings are at odds with established lines of thought receive particular attention.

MP 3123
LINKS BETWEEN SNOWPACK PHYSICS AND SNOWPACK CHEMISTRY.
Davis, R.E., *NATO Advanced Science Institutes. Series G,* 1990, Vol.28, NATO Advanced Research Workshop on Processes of Chemical Change in Snowpacks, Maratea, Italy, July 23-27, 1990. Proceedings. Seasonal snowpacks—processes of compositional change. Edited by T.D. Davies et al, p.115-138, 60 refs.
46-5015
SNOW COVER STABILITY, METAMORPHISM (SNOW), SNOW PHYSICS, SNOWMELT, CHEMICAL COMPOSITION, WATER FLOW, SNOW HYDROLOGY, LEACHING, ICE WATER INTERFACE, SOLUTIONS.
This paper includes two major parts. Theories and observations of dry and wet snow metamorphism are surveyed with discussions on the location and migration of chemical species, followed by a review of observations of heterogeneous water flow and some attempts to model percolation in two modes. Next, the theory of water flow coupled to solute transport is presented for homogeneous flow in a homogeneous snow layer. A method accounting for water flow in multiple paths is described, summarizing the difficulties of coupling solute flow. Both the discussion of metamorphism and water flow in snow conclude with comments on the disparity between theory and measurements, especially as it relates to the effects of stratigraphy of snow covers. The review here does not cite all of the work in this field, but summarizes what this author considers to be the important concepts and gaps in understanding the links between snow pack physics and chemistry.

MP 3125
SPECIMEN PREPARATION FOR ICE RESEARCH.
Garcia, N.B., *Cold regions science and technology,* Apr. 1985, 10(3), p.273-275, 4 refs.
46-5286
ARTIFICIAL ICE, ICE SAMPLING, ICE MAKERS, ARTIFICIAL FREEZING, LABORATORY TECHNIQUES.

MP 3126
INSTRUCTIONS FOR MAKING SNOW OBSERVATIONS.
U.S. Army Corps of Engineers. Snow, Ice, and Permafrost Research Establishment, *SIPRE instruction memorandum,* 1953, No.1, 8p.
46-5325
SNOW SURVEYS, SNOW COVER STRUCTURE, SNOW SURFACE, SNOW HARDNESS, SNOW CRYSTAL STRUCTURE.

MP 3127
VIBRATION IN PERCUSSIVE DRILL RODS.
Dutta, P.K., International Conference on Vibration Problems of Mathematical Elasticity and Physics, 1st, Jalpaiguri, India, Oct. 20-23, 1990. Proceedings. Edited by M.M. Bannerjee and P. Biswas, Jalpaiguri, A.C. College, 1990, 13p., 12 refs.
46-5330
ROCK DRILLING, PERCUSSION DRILLING, DAMPING, VIBRATION, NOISE (SOUND), SHOCK WAVES, STRESSES, MATHEMATICAL MODELS.

MP 3128
THEORY OF STRENGTH DEGRADATION OF UNIDIRECTIONAL FIBER COMPOSITES AT LOW TEMPERATURE.
Dutta, P.K., Industry-University Advanced Materials Conference II, Denver, CO, Mar. 6-9, 1989. Proceedings. Edited by F.W. Smith, Golden, CO, Colorado School of Mines, Advanced Materials Institute, 1989, p.647-662, 19 refs.
46-5331
COMPOSITE MATERIALS, LOW TEMPERATURE TESTS, COLD STRESS, RESINS, POLYMERS, TENSILE PROPERTIES, COLD WEATHER PERFORMANCE, TEMPERATURE EFFECTS, MATHEMATICAL MODELS.
Recent studies have shown that unidirectional polymeric composites, when loaded at low temperature in the direction of the fibers, fail at lesser loads than when loaded at room temperature. Evidence of such strength reduction in the cold has been observed in fiberglass-epoxy, carbon-epoxy and Kevlar-epoxy composites. A hypothesis is put forward based on the development of stress concentrations in fibers embedded in the cold hardened matrix. At room temperature the resin is relatively less stiff; it tends to allow the wavy fibers to align in the direction of loading and share the load uniformly. At low temperature the resin is stiffer; since the fibers cannot align, the waviness persists and local stress concentration causes the fibers to fail.

MP 3134
THERMAL EFFECTS DUE TO AIR FLOW AND VAPOR TRANSPORT IN DRY SNOW.
Albert, M.R., et al, 1992, 38(129), p.273-281, 21 refs.
McGilvary, W.R.
47-468
SNOW AIR INTERFACE, SNOW THERMAL PROPERTIES, SNOW TEMPERATURE, VAPOR TRANSFER, HEAT TRANSFER, SUBLIMATION, TEMPERATURE EFFECTS, CONVECTION, ANALYSIS (MATHEMATICS), FORECASTING, THERMAL REGIME.
The thermal effects of air flow forced through a snow sample are investigated numerically. A new method for calculating vapor transport in snow is presented which allows for the determination of the effects of sublimation. In this method, the snow is not assumed to be saturated with water vapor. Results of the model show very good agreement with analytical and experimental results. It is demonstrated that the heat transfer associated with vapor transport is significant in the determination of the overall temperature profile of a ventilated snow sample, but that the major effects are controlled by the heat carried by the dry air flow through the snow and heat conduction due to the temperatures imposed at the boundaries. 504 $Journal of glaciology

MP 3135
ICE-BLISTER OBSERVATIONS ON GLACIERS, SEA ICE AND RIVERS.
Kovacs, A., *Journal of glaciology,* 1992, 38(129), p.314-316, 15 refs.
47-473
ICE SHEETS, ICING, ICE SURFACE, FROST MOUNDS, FROST ACTION, SURFACE PROPERTIES.
In this letter, the author offers an elaboration of information concerning ice-blister location and morphology presented in a previous paper of the journal. This feature is not confined to glacier surfaces, but has been reported on sea ice and river surfaces as well. Details concerning the distribution and formation of ice-blisters are also related.

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